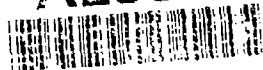


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IMPLEMENTATION DOCUMENT
FOR
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA

VOLUME 1 GENFRAL
VOLUME 2 SPECIFICATIONS
VOLUME 3 DRAWINGS

June 1990




Shell Oil Company

REPORT DOCUMENTATION PAGE

Form Approved
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IMPLEMENTATION DOCUMENT
FOR
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA

VOLUME 1 GENERAL
VOLUME 2 SPECIFICATIONS
VOLUME 3 DRAWINGS

June 1990

Prepared by
MK-Environmental Services
Denver, Colorado 80203

Prepared for
Shell Oil Company
Denver, Colorado 80203

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Rocky Mountain Arsenal
Information Center
Commerce City, Colorado

NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS
IMPLEMENTATION DOCUMENT

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IMPLEMENTATION DOCUMENT FOR INTERIM RESPONSE ACTION
FOR NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS
AT THE ROCKY MOUNTAIN ARSENAL

SECTION 1.0

INTRODUCTION

The Interim Response Action (IRA) for the Groundwater Intercept Modifications for the Northwest Boundary System Short-Term Improvements is being conducted as part of the IRA Process for the Rocky Mountain Arsenal (RMA) in accordance with the June 5, 1987 report to the court United States v. Shell Oil Company and the Federal Facility Agreement effective February 17, 1989.

On April 13, 1990, the Northwest Boundary System Improvements IRA was divided into two phases: Short Term Improvements and Long-Term Improvements. The Short Term Improvements include assessment of the alluvial intercept system and extension. The Long-Term Improvements will involve a more thorough assessment of the Northwest Boundary Containment and Treatment System.

The Lead Role for the assessment, detailed design, and construction of the Short-Term Improvements was transferred from the Army to Shell on April 13, 1990. The Short-Term Improvements are to be performed on an accelerated basis in order to complete construction in the calendar year 1990. To accelerate the process, this abbreviated Implementation Document has been prepared in conjunction with the Decision Document. The Decision Document will become final June 4, 1990.

The detailed design incorporates the concepts proposed in the Decision Document. A construction cost estimate and schedule have been prepared and are included. The cost of design and

construction for the first phase is estimated to be \$900,000.00 and the basis of the estimate is given in Section 4. The deadline for completion of this project (and "IRA Deadline" under the Federal Facility Agreement) is November 30, 1990, subject to extension as described in Section XXVI of the Federal Facility Agreement. Intermediate dates shown in this document comprise the "Schedule" (as defined in the Federal Facility Agreement) are not "Deadlines" under the Federal Facility Agreement.

As discussed in The Decision Document for the Northwest Boundary System Short-Term Improvements, the existing groundwater intercept system will be extended both to the southwest and northeast. More specifically, the soil-bentonite wall will be extended across the alluvial channel found north of the system. Additional extraction wells will be added to the existing system to intercept and treat the water in this channel.

Per the meeting of the Parties on May 17, 1990, new extraction wells and recharge wells will be added to the existing system, extending the intercept system to the southwest. To not delay the construction of the northeast extension of the groundwater intercept system, detailed design for the southwest extension has not been addressed in this document. A detailed design package for the southwest extension of the intercept system will be issued at a later date as an addendum to this Implementation Document.

MEMORANDUM OF UNDERSTANDING BETWEEN
THE DEPARTMENT OF THE ARMY AND SHELL OIL COMPANY
WITH RESPECT TO
RESPONSE ACTION WORK CONDUCTED PURSUANT TO THE
FEDERAL FACILITY AGREEMENT

I. PARTIES

This Memorandum of Understanding ("MOU") specifies the cooperative undertakings which are to occur between the Army (a potentially responsible party under CERCLA) and Shell (a potentially responsible party under CERCLA) with respect to any Scope of Work developed pursuant to the Federal Facility Agreement now or hereafter attached as an exhibit to this MOU.

II. PURPOSE

The purpose of this MOU is to provide an appropriate basis pursuant to the Federal Facility Agreement for Shell to participate in the expeditious (a) assessment, selection, design and implementation of an IRA or (b) operation and maintenance of any Response Action Structure.

III. DEFINITIONS

The following terms, used in the MOU, shall have the meanings indicated:

(a) "Army" means the United States Department of the Army, and any successors or assigns thereof, and any agency, office or other subdivision thereof; and includes the officers, members, employees and agents of the Army when acting within the scope of their authority.

(b) "Arsenal" means the United States property known as the Rocky Mountain Arsenal and described more particularly on Exhibit A hereto.

(c) "CERCLA" means the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986.

(d) "Contractor" means any commercial party not a part of Shell with which Shell contracts for the performance of Response Action work pursuant to this MOU. Unless otherwise indicated, the term also includes a subcontractor retained by a prime Contractor or another subcontractor.

(e) "Federal Facility Agreement" means the Federal Facility Agreement for Rocky Mountain Arsenal, effective February 17, 1989, including all exhibits thereto (and any amendments or modifications thereof or supplements thereto).

(f) "Financial Manual" means the document identified in paragraph 7.4 of the Settlement Agreement.

(g) "Force Majeure" means any event arising from causes beyond the control of an Organization that causes a delay in or prevents the performance of any obligation under this MOU. "Force Majeure" includes, but is not limited to: acts of God; fire; war; insurrection; civil disturbance; explosion; unanticipated breakage or accident to machinery, equipment or lines of pipe, despite diligent maintenance; adverse weather conditions which could not be reasonably anticipated; unusual delay in transportation; earthquake; restraint by court order or order of public authority; inability to obtain, at reasonable cost and after exercise of reasonable diligence, any necessary authorizations, approvals, permits or licenses as a result of the action or inaction of any governmental agency or authority other than the Army; delays caused by compliance with applicable statutes or regulations governing contracting, procurement or acquisition procedures, despite the exercise of reasonable diligence; and insufficient availability of appropriated funds, if the Army shall have made timely request for such funds as part of the budgetary process. "Force Majeure" also includes any strike or labor dispute, whether or not within the control of the Organization affected thereby, but shall not include increased costs or expenses of Response Actions, whether or not anticipated at the time such Response Actions were initiated.

(h) "IRA" means an Interim Response Action identified in Section XXII of the Federal Facility Agreement.

(i) "Lead Party" means the Organization that is designated with responsibility, in accordance with Section XLIII of the Federal Facility Agreement, for conducting a Response Action, or any part thereof.

(j) "MOU" or "Memorandum of Understanding" means to this entire document and any amendments or modifications hereof and supplements hereto, and all documents incorporated herein by reference.

(k) "NCP" means the National Oil and Hazardous Substances Pollution Contingency Plan, 50 Fed. Reg. 47912 (1985) (effective February 18, 1986), and all amendments thereto which are not inconsistent with CERCLA and which are effective and applicable to any activity undertaken pursuant to this MOU.

(l) "Organization" means the Army, EPA or Shell.

(m) "Party" means the Army or Shell; "Parties" means the Army and Shell.

(n) "Response Action" has the same meaning as "Respond" or "Response" as defined in Section 101(25) of CERCLA, 42 U.S.C. § 9601(25).

(o) "Scope of Work" means a document identified in Part VI by which any Response Action work for which Shell is the Lead Party shall be conducted.

(p) "Settlement Agreement" means the "Settlement Agreement Between the United States and Shell Oil Company Concerning Rocky Mountain Arsenal," effective February 17, 1989, including all exhibits thereto (and any amendments or modifications thereof or supplements thereto).

(q) "Shell" means (a) Shell Oil Company and its successors and assigns, (b) the divisions thereof, including Shell Chemical Company, (c) Julius Hyman & Co., and (d) Shell Chemical Corporation; and includes the officers, employees and agents of Shell when acting within the scope of their authority.

All other capitalized terms used in this MOU shall have the same meaning as in the Federal Facility Agreement or the Settlement Agreement or the meaning specified in an executed Scope of Work.

IV. SCOPE OF MOU

This MOU, the Federal Facility Agreement and the Settlement Agreement constitute the entire understanding between the Army and Shell with respect to Shell's assisting the Army in the Response Action work described in an executed Scope of Work, except for any subsequently executed Scope of Work which the Parties may execute with respect to such Response Action work; constitute the sole conditions controlling Shell's participation in such Response Action work; and with respect to such Response Action work, supersede any other agreement(s) between the Parties. In the event a conflict between the provisions of the Federal Facility Agreement and the Settlement Agreement and this MOU, the provisions of the Federal Facility Agreement and the Settlement Agreement shall govern.

V. OPERATION OF MOU

By their execution of this MOU, each of the Parties acknowledges and agrees as follows:

(a) The provision of the Response Action work pursuant to this MOU is a reasonable and appropriate contribution to the assessment, selection, design and implementation of Response Actions that are protective of the present and future public health and the environment.

(b) The Army's actions under this MOU are not inconsistent with the NCP.

(c) Shell's actions under this MOU, to the extent certified by the Army pursuant to Subpart VI.E., are consistent with the NCP.

(d) This MOU does not operate to establish or to excuse any Shell or Army liability under any law, the Federal Facility Agreement or the Settlement Agreement, except to the extent provided in this MOU.

(e) This MOU does not operate to render Shell or any of its Contractors a CERCLA response action contractor.

(f) This MOU does not operate to expand or limit any of the rights and obligations of the Army as Lead Agency or Shell as Lead Party under any law or the Federal Facility Agreement.

(g) Unless otherwise provided in a Scope of Work, upon acceptance of the Response Action work pursuant to Subpart VI.E, title to any Response Action Structure including all related systems and facilities constructed as a part of that Response Action work shall pass to the United States.

(h) The Army shall be solely responsible for obtaining necessary permits, if any, and for establishing substantive compliance with all permitting requirements pursuant to Section 121(e) of CERCLA, 42 U.S.C. 9621(c), for any activities conducted pursuant to this MOU. However, Shell shall provide any necessary technical support necessary for the Army to obtain such permits.

(i) This MOU has no precedential or controlling effect with respect to any matter which is not expressly the subject of this MOU.

(j) This MOU does not create or impose any obligations or responsibilities on the Parties or relieve them of any obligations or responsibilities, except to the extent expressly provided herein.

VI. SHELL'S PERFORMANCE OF RESPONSE ACTION WORK

A. Development of Scope of Work: Pursuant to Section XLIII of the Federal Facility Agreement, the Army and Shell shall develop Scopes of Work by which Response Action Work for which Shell is the Lead Party shall be conducted. A Scope of Work shall include any required data or specifications for the Response Action work to be performed, a projected schedule for completion and a statement as to the appropriate limits of insurance to be maintained by Shell pursuant to Part VII.

B. Incorporation into this MOU: Any Scope of Work developed pursuant to Subpart VI.A and executed by the Army and Shell, and all the terms and conditions therein are incorporated by reference into this MOU.

C. Performance of Work: Upon execution of the Scope of Work by the Army and Shell, Shell shall immediately commence, in consultation and cooperation with the Army, as provided in the Consent Decree, to perform the Response Action work described in the Scope of Work.

D. Hiring of Contractor: Subject to the approval of the Army, Shell may hire at its sole expense, subject to Part VII, a Contractor to perform any Response Action work described in a Scope of Work. A Contractor may be terminated by Shell with the approval of the Army, which approval shall not be unreasonably withheld. Any disagreement with respect to such termination not resolved informally shall be resolved in accordance with the provisions of Part XIII.

E. Acceptance of Work: 1. If Shell performs the Response Action work in accordance with the specifications set forth in the applicable Scope of Work, the Army shall accept Shell's work pursuant to this MOU. The Army shall act promptly to accept Shell's work, and acceptance shall not be unreasonably withheld. Should the Army decline acceptance, it shall promptly notify Shell in writing, stating with specificity the factual, technical and legal bases for such nonacceptance.

2. If Shell concludes that the Army is in error for treating Shell's performance as incomplete or unacceptable for any other reason, Shell shall give notice in writing, within ten business days of the receipt of the Army's written notification, that Shell disagrees. Any such disagreement, if not resolved informally, shall be resolved in accordance with the provisions in Part XIII.

VII. SHELL INSURANCE OBLIGATIONS

Shell shall maintain such insurance or self-insurance as is required by statute or regulation to cover any claims which may reasonably be anticipated to be made as a result of Response Action work done pursuant to any Scope of Work attached as an exhibit to this MOU. At a minimum, Shell shall, at its sole option, procure insurance, maintain insurance or self-insure sufficiently to cover the following:

1. Worker's compensation and occupational disease insurance in amounts sufficient to satisfy applicable state law;
2. Employer's liability insurance in the minimum amount of \$100,000 per occurrence; and
3. Comprehensive general liability insurance for bodily injury, death or loss of or damage to property of third persons in the minimum amount of \$100,000 per occurrence.

Upon this MOU becoming effective, Shell shall promptly provide the Army with an affidavit that Shell is in compliance with the minimum requirements of this Part. Upon the signing of a Scope of Work, Shell shall promptly provide the Army with an affidavit that Shell is in compliance with this Part as to that Scope of Work. Upon request, Shell shall discuss with the Army the manner in which Shell will fulfill its obligations under this Part.

VIII. ARMY SUPPLEMENTATION OF SHELL INSURANCE

If the Response Action work being performed is an Army-Only Response Action, as defined in the Settlement Agreement, the Army shall release, defend, indemnify and hold harmless Shell from all losses, fines, penalties, claims, suits, liabilities, judgments, or expenses (including expenses of litigation or settlement) (collectively hereinafter in this Part VIII, "claim") with respect to any death or injury to any person or loss of or damage to property to the extent that these result from the construction, operation, collapse, rupture or failure of any Response Action Structure, or any part thereof, after the Army's acceptance pursuant to Subpart VI.E. or the operation, collapse, rupture, failure or ineffectiveness of the Response Action Structure as a result of the construction, operation, collapse, rupture or failure of the Response Action work when such claim is not compensated by insurance or self-insurance, to the extent provided below:

- (a) Shell is not in material breach of this MOU with respect to the Scope of Work pursuant to which such Response

Action work was performed or such Response Action Structure was constructed;

(b) Any claim which is within the deductible amounts of Shell's insurance shall not be subject to this Part;

(c) Shell shall not be reimbursed for any claims (including expenses incidental to such claims) to the extent that they result, in whole or in part, from willful misconduct or recklessness by Shell;

(d) The Army may discharge its obligations under this Part by making payments directly to Shell or directly to any party to whom Shell may be liable upon obtaining a release from that party, which release provides adequate protection for Shell.

(e) If insurance coverage maintained in accordance with Part VII is reduced below the minimums specified in that Part without the Army's knowledge or approval, the liability of the Army under this MOU shall not be increased by reason of such reduction;

(f) To the extent that any claim against Shell may reasonably be expected to involve indemnification under this Part, Shell shall:

(1) promptly notify the Army of such claim against Shell;

(2) furnish evidence or proof of any claim covered by this Part in the manner and form reasonably requested by the Army; and

(3) immediately furnish the Army with copies of all pertinent papers received by Shell.

(g) To the extent that the amount of the claim is not determined to be in excess of the limits set forth in Part VII or to the extent that the amount of the claim cannot reasonably be determined to be or not to be in excess of those limits, Shell and the Army shall conduct a joint defense or settlement. Once it is determined that the amount of the claim is in excess of the limits set forth in Part VII, the Army shall direct and control such defense or settlement, with assistance by Shell as is acceptable to both Parties, and Shell shall execute any authorizations which the Army reasonably requires in connection with such settlement.

(h) Reimbursement for any claims under this Part shall not exceed appropriations available during the time that

such claims are represented by final judgments or by settlements approved in writing by the Department of Justice. This agreement to reimburse Shell for certain claims shall not be interpreted as implying that Congress shall, at a later date, appropriate funds sufficient to meet any deficiencies. During all times that claims remain unreimbursed due to lack of appropriated funds, the Army shall exert its best efforts to obtain appropriations for such reimbursement.

IX. TREATMENT OF COSTS INCURRED
BY SHELL PURSUANT TO THIS MOU

Any costs incurred by Shell pursuant to this MOU are Reimbursable Costs and shall be governed by the Settlement Agreement and the Financial Manual.

X. DELAY OR PREVENTION OF PERFORMANCE

A. As provided in the Consent Decree, if a Party is rendered unable, wholly or in part, by Force Majeure to carry out its obligations under this MOU, then upon that Party's giving written notice as provided in Subpart XI.C., the obligations of that Party, so far as they are affected by the event of Force Majeure therein specified, shall be suspended during the continuance of such cause, but for no longer period, and such cause shall be remedied so far as possible with all reasonable dispatch.

B. The settlement of a strike or other labor dispute shall be entirely within the discretion of the Party involved with such strike or labor dispute, and the requirement that any event of Force Majeure shall be remedied with all reasonable dispatch shall not require the settlement of a strike or labor dispute by acceding to the demands of the opposing party when such course is inadvisable in the discretion of the Party involved with such strike or labor dispute.

C. When circumstances are occurring or have occurred that delay the completion of any obligation, and a Party believes such circumstances constitute an event of Force Majeure, such Party shall notify the other Organizations in writing within 15 days after the notifying Party obtains information indicating that a delay will occur. Such notice shall include a detailed explanation of the reason(s) for and anticipated duration of the delay, the measures taken and to be taken to prevent or minimize the delay, and a schedule for implementation of such measures. Failure to provide notice in accordance with this paragraph within the required 15-day period shall constitute a waiver of any claim of Force Majeure with respect to any event of Force Majeure for which notice was not timely given.

D. If the Organizations cannot agree whether a delay is or was attributable to an event of Force Majeure, any Organization may invoke Dispute Resolution pursuant to Section X of the Settlement Agreement.

E. Scope of Work Modification: If performance of this MOU is delayed because any Party finds it necessary to make modifications to address an unanticipated occurrence which may cause a delay of more than two weeks, such modifications shall be developed and implemented by Shell in consultation and cooperation with the Army. Any disputes not resolved informally shall be resolved pursuant to the provisions of Part XIV. Further, if Shell anticipates the delay resulting from any such modifications will necessitate the extension of a Deadline, it shall request such an extension in accordance with Section XXVI of the Federal Facility Agreement.

F. Unaffected Activities: To the extent that the unanticipated occurrence does not necessitate delay in any discrete portion(s) of the activities provided in Part VI, such portion(s) of the activities shall proceed as originally provided in the MOU irrespective of the need for modification of other parts of the MOU.

XI. SHELL ACCESS TO ROCKY MOUNTAIN ARSENAL

Shell and its Contractors shall be afforded access to all relevant portions of the RMA in order to perform its obligations under the MOU pursuant to the terms and conditions of the Access and Use Agreement attached as Exhibit E to the Settlement Agreement until such time as the Army and Shell execute an applicable superseding agreement.

XII. DISPUTE RESOLUTION AND JUDICIAL REVIEW

A. Dispute Resolution: Any dispute which arises in connection with this MOU may be submitted for resolution pursuant to Section X of the Settlement Agreement. Prior to any such submission, Shell and the Army shall meet and attempt to resolve the dispute informally.

B. Judicial Review: 1. Judicial review of issues arising in connection with this MOU shall be obtained pursuant to Section XI of the Settlement Agreement.

2. The pendency of any dispute shall not affect the responsibility of the United States or Shell to continue their involvement in the assessment, selection, design and implementation of Response Actions, or discrete portions of Response Actions, not subject to such dispute.

(III) GENERAL

A. Term: This MOU shall continue in effect as to a specific Scope of Work until the Army, pursuant to Subpart VI.E, accepts Shell's work pursuant to this MOU, and the reimbursement or payment has been made pursuant to Part IX.

B. Modification: Any provision of this MOU or of any Scope of Work may be modified at any time by both Parties' agreement. Any modification must: (1) be in writing; (2) show the date signed by the Parties; (3) specify that it is intended to modify this MOU; (4) state the provisions of the MOU to be modified; (5) state the new provisions; and (6) state when the new provisions are to be effective.

C. Effect of Execution: This MOU shall become effective on the later of its execution by the Parties or the entry of the Consent Decree. A Scope of Work shall become effective, final and binding upon its execution.

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the United States Department of the Army.

Date: 1/23/89

Lewis D. Walker
Lewis D. Walker

Deputy for Environment, Safety
and Occupational Health

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of Shell Oil Company.

Date: _____

R.G. Dillard
Vice President

XIII. GENERAL

A. Term: This MOU shall continue in effect as to a specific Scope of Work until the Army, pursuant to Subpart VI.E., accepts Shell's work pursuant to this MOU, and the reimbursement or payment has been made pursuant to Part IX.

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IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of the United States Department of the Army.

Date: _____

Lewis D. Walker
Deputy for Environment, Safety
and Occupational Health

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of Shell Oil Company.

Date: 2/15/89

R. G. Dillard
R.G. Dillard
Vice President

ROCKY MOUNTAIN ARSENAL - INTERIM RESPONSE ACTIONS
NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS

SCOPE OF WORK

Shell will perform the following activities as lead party for design and implementation of the Northwest Boundary System Short-Term Improvements Interim Response Action:

1. Perform the preliminary investigation required to develop a Detailed Engineering Design Package which will be in conformance with the selected alternatives set forth in the Final Decision Document including the following:
 - a. Extend the existing, slurry wall to the Northeast across the alluvial channel found in recent investigations.
 - b. Extend the existing Northwest Boundary extraction system to extract water from the subject alluvial channel.
 - c. Add additional monitoring wells on the recharge side of the barrier wall.
2. Prepare final Implementation Document and issue the final Northwest Boundary System Short-Term Improvements Implementation Document for review and approval by the Army.
3. Perform all work in connection with construction of Northwest Boundary System Short-Term Improvements as described more fully in the Northwest Boundary System Short-Term Improvements Implementation Document (as defined below), including the following:

- a. Procurement of all required materials and subcontractors.
- b. Supervisory and construction labor to manage subcontractors and install wells, piping, utilities and slurry wall.
- c. Testing and supervision of startup of the Northwest Boundary System Short-Term Improvements upon completion of construction.
- d. Site cleanup and final grading of any disturbed areas in preparation of reseeding by the Army.
- e. All activities described in this paragraph 3 shall be performed in accordance with the construction work plan, basis of the estimated cost, schedule, technical specifications, engineering drawings, and health and safety plan to be set forth in the Northwest Boundary System Short-Term Improvements Implementation Document.
- f. The term "Northwest Boundary System Short-Term Improvements Implementation Document" means the following document which is hereby incorporated herein by reference:

Final Implementation Document for IRA to extend the existing groundwater intercept system in the Northwest Boundary area. This document to be prepared by MK-Environmental Services for Shell and any amendments or modifications thereof and supplements thereto.

As set forth in the Final Decision Document, the Implementation Document must be completed by July 1, 1990.

Due to this accelerated schedule of this project, Shell will submit fifty (50) complete copies of the Draft/Final Implementation Document to all parties prior to the above deadline. Within 7 days of issuance, a meeting will be held to discuss comments regarding the document. Shell will submit forty (40) copies of the Final Implementation Document to the Army within 10 working days of the meeting. The Army will distribute the Final Implementation Document to all parties within five (5) days of receipt.

6. During performance of construction of this Interim Response Action, Shell shall submit a monthly letter progress report to the Army summarizing work performed versus work planned, highlighting major items completed, and updating the schedule of construction until the Interim Response Action is completed. Monthly letter reports shall be submitted to the Army within ten (10) working days after the end of each monthly reporting period. At the close of the project, a letter will be provided to the Army summarizing the work completed.

IN WITNESS WHEREOF, I have hereunder set my hand as a authorized representative of the United States Department of the Army.

Date

5/25/90



Deputy Program Manager

IN WITNESS WHEREOF, I have hereunder set my hand as an authorized representative of Shell Oil Company.

Date

May 25, 1990



Manager Projects, Denver Site Project

ROCKY MOUNTAIN ARSENAL - INTERIM RESPONSE ACTIONS
NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS

SECTION 3.0

CONSTRUCTION WORK PLAN

1. Survey: Area will be staked to locate and define the limits of excavation and location of facilities.
2. Soil Investigation: Prior to the beginning of the construction work the areas to be excavated will be investigated for contaminants as outlined in the Health and Safety Plan.
 - A. Slurry Wall: One hole will be drilled to one foot below planned excavations and tested at five foot increments to investigate volatile organic levels.
 - B. Pipeline Trenches: One hole every 500 feet will be drilled to approximately one foot below planned excavations in the alignment of each pipeline and tested every five feet of depth to investigate the presence of volatile organic substances.
 - C. Should findings warrant further investigations, additional testwork will be specified and implemented.
3. Slurry Wall: Excavation will be performed in two phases as discussed below:
 - A. Bench: Upper 10 feet of existing soil, will be excavated down to establish a lower working platform to

minimize vertical trenching and create an area to stockpile potentially contaminated soils from the vertical trench excavation.

- B. Vertical Trench Excavation: The remaining depth of excavation will be trenched with a 30" to 36" wide bucket to the elevations selected in the field by the geologist.

Note: Potentially contaminated soil will be stockpiled on one side of the benched platform to isolate the soil removed during the trenching operation. Personnel working on this side of the trench will decontaminate their clothing prior to leaving this area or crossing the trench if contaminant levels are found to warrant these measures.

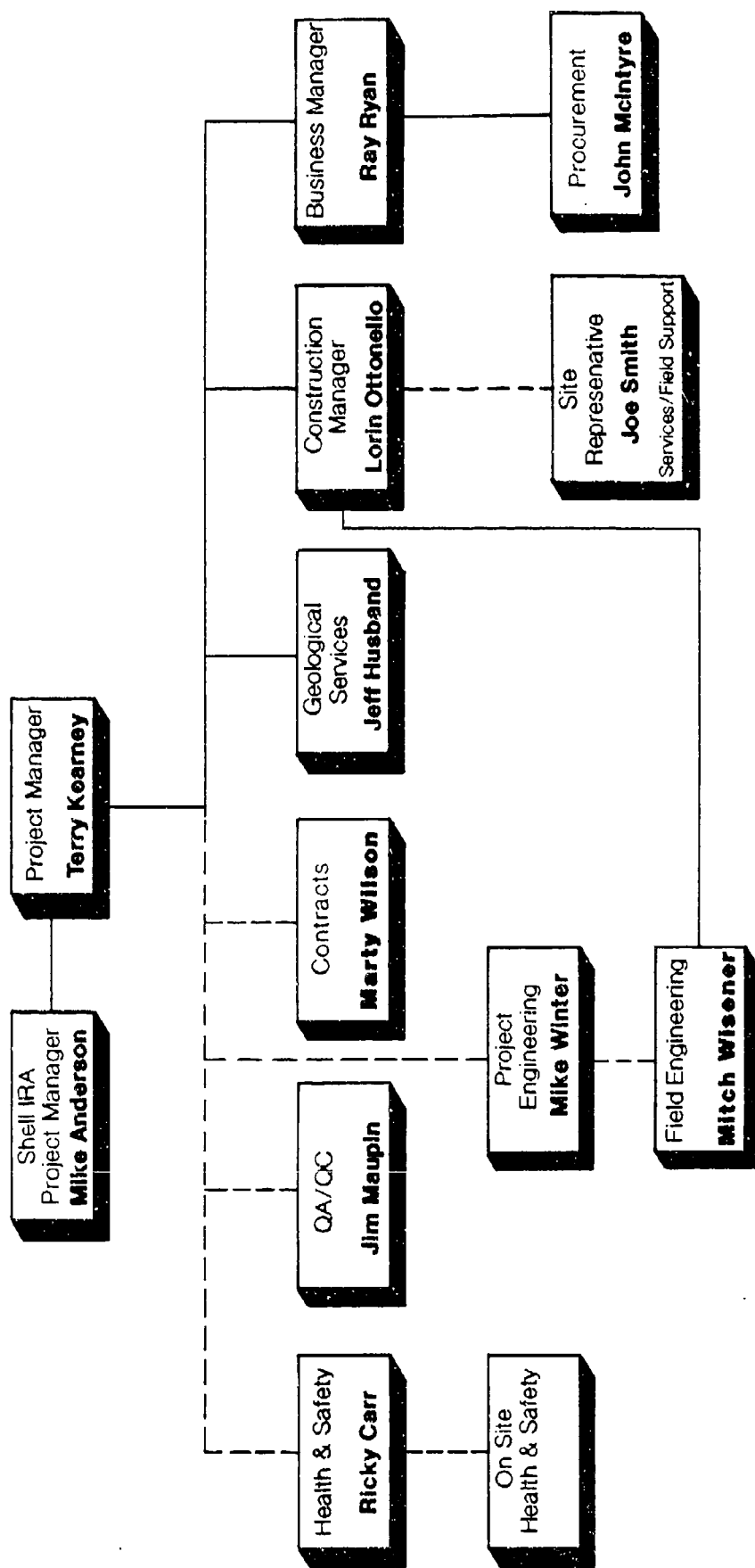
4. Dust Control: During the period when earth moving and excavation operations are in progress a water truck will be on site and the surfaces will be sprayed to maintain the surface soil moisture content and control the evolution of dust.
5. Geological Services: An onsite geologist will monitor the construction work to establish depth of excavation along the length of each trench and log information for future reference.
6. Health & Safety: A site Health and Safety Officer will monitor the work and test the excavations with an OVA and PID to ensure worker's safety and identify any volatile organic compounds that may be encountered.
7. Reporting: The Construction Manager shall prepare Daily Construction Reports to record field activities.

Separately, a daily personnel log shall be used to record the names of all personnel who have visited the site.

As described in the IRA Scope of Work, a summary of IRA construction activities will be presented to the Army on a monthly basis.

8. Organization: An organization chart for the construction of the Northwest Boundary System Short-Term Improvements IRA is attached.

ORGANIZATION CHART
THE NORTHWEST BOUNDARY SYSTEM
SHORT TERM IMPROVEMENTS IRA



ROCKY MOUNTAIN ARSENAL - INTERIM RESPONSE ACTIONS
NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS

SECTION 4.0

BASIS OF THE CONSTRUCTION COST ESTIMATE

The attached Construction Cost Estimate has been prepared for implementation of the Short-Term Improvements for the Northwest Boundary System. Included in the estimated costs are the design, the extension of the existing soil-bentonite barrier, the extension of the existing dewatering system, and the addition of monitoring wells as defined in the enclosed engineering specifications (Volume II), and the enclosed drawings (Volume III). The subject specifications and drawings were completed on May 18, 1990, and were subsequently issued in May 1990 as part of this Draft Implementation Document for review and comment by the parties.

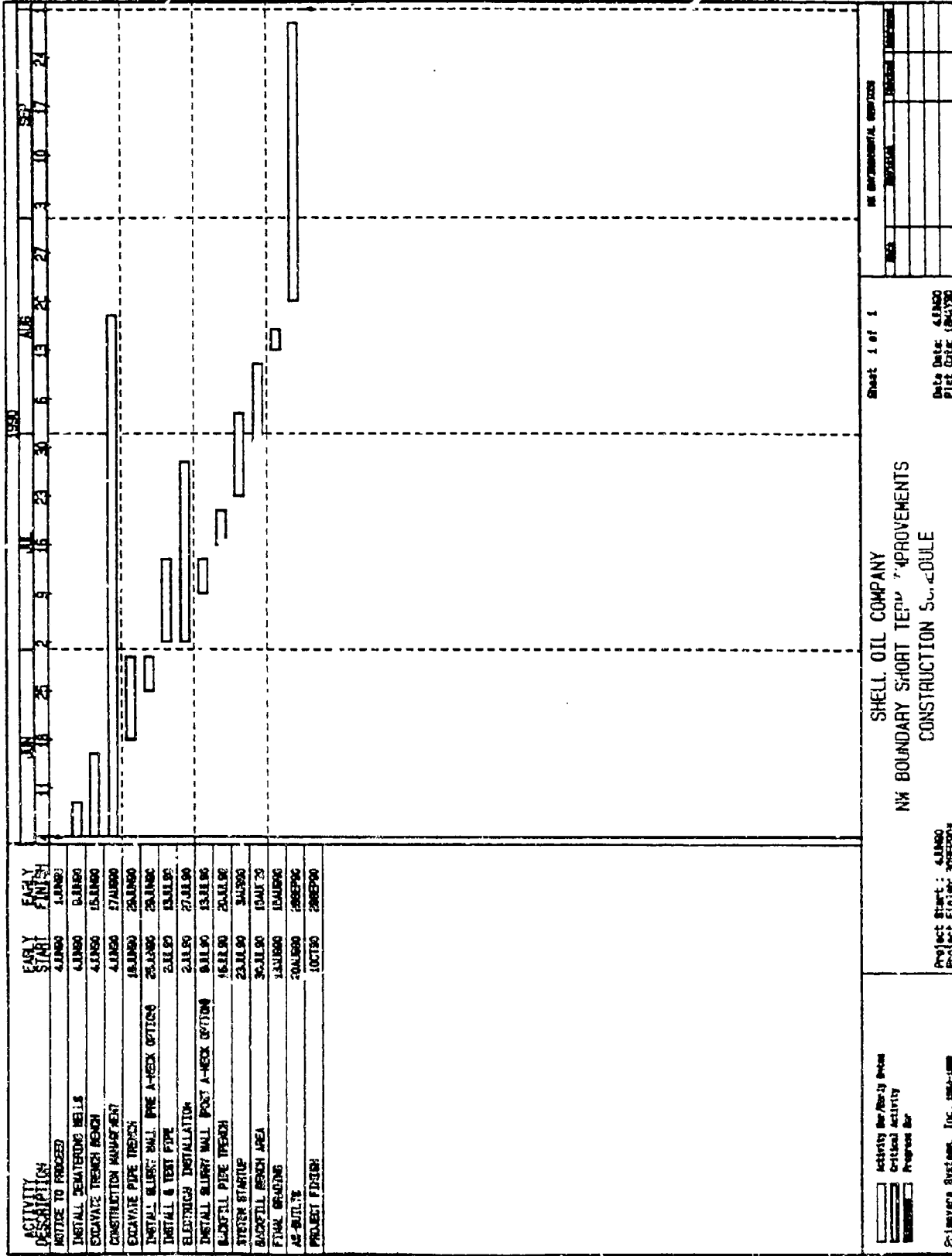
Due to the accelerated schedule of the IRA, the estimate provided is a budget estimate only. Costs are based on unit prices developed from previous similar work.

Indirect costs for construction management, Contractor's overhead and fee, and the Health and Safety Program are also included in the estimate. The estimate has been prepared on the basis of MK-Environmental acting as construction manager for Shell Oil Company and subcontracting all work.

For the development of health and safety supplies cost as well as labor productivity estimates, it was assumed that all work will be performed with Level C personnel protection.

NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS
ESTIMATE BREAKDOWN
(NORTHEAST EXTENSION)

1.	Design	\$ 70,000.00
2.	Working Bench	75,000.00
3.	Barrier Wall Extension	242,000.00
4.	Underground Water Distribution	25,900.00
5.	Dewatering, Recharge and Monitoring Wells	18,000.00
6.	Electrical Distribution and Controls	70,000.00
7.	Health & Safety	80,000.00
8.	Construction Management	117,000.00
9.	Contingency, Fee and Distributable Allocation	<u>203,000.00</u>
	Total	\$900,000.00



1.0 INTRODUCTION/SCOPE

This Task-Specific Health and Safety Plan (TSHSP) provides the basis for performing the Northwest Boundary System Short-Term Improvements Interim Response Action in a way that will control and minimize the risk to the health and safety of MK and subcontractor personnel. The plan defines the specific requirements and protocols for the protection of personnel performing the work.

Applicability of the TSHSP extends to all MK employees, subcontractors, and site visitors under MK's control. This work will be performed in accordance with the MK RMA Project Safety and Health Program, the RMA Site Safety and Health Plan, and all federal occupational health and safety rules and regulations.

This TSHSP will be reviewed by all MK and subcontractor personnel involved with the task prior to performing the work.

2.0 HAZARD ASSESSMENT

2.1 Chemical Hazards

Historical information indicates that the following chemical compounds have been detected in the groundwater in the area that the work will be performed.

<u>Chemical</u>	<u>TLV/PEL*</u>
Chloroform	2ppm
Dieldrin (skin)	0.25mg/m ³
Benzene	1ppm
Chlorobenzene	10ppm ¹
DIMP	--
Trichloroethane (skin)	50ppm

* The most restrictive value - TLV or PEL.

¹ TLV in notice of intended changes (1989-1990).

Chloroform, Dieldrin and Benzene are considered suspect or confirmed human carcinogens.

The concentrations of these chemicals in the groundwater pose a small potential exposure risk to personnel involved with activities that may involve contact with the groundwater. It is anticipated that the primary potential exposure risk is respiratory. Although a few of the detected compounds can be absorbed through the skin and mucous tissues, the detected concentrations are far below the levels generally associated with adverse effects. However, a potential cutaneous exposure risk may be present if previously undetected substances are present or known constituents are present in higher concentrations than previously detected.

Concentrations of volatile organic compounds may accumulate in confined spaces. Organic compounds may be further volatilized by disturbance of contaminated groundwater. Dispersion of the volatile organic compounds is anticipated

to occur in the ambient air before reaching the breathing zone of personnel.

The symptoms of exposure to the chemicals known to be present in the groundwater are similar although the concentrations which produce the symptoms may vary. Volatile organic materials produce odors particular to each compound, and the detection of any unusual odors should be considered an indication of potential exposure through inhalation. Medical symptoms produced generally depend upon the extent of exposure. Initial symptoms include irritation of the mucous membranes of the nose and throat, eye irritation, headache, nausea and dizziness. Long duration exposure to low concentrations, or acute exposures to high concentrations of contamination may produce weakness, vomiting, abdominal pain and central nervous system impairment (manifested by tremors, numbness in the limbs, lack of coordination, or unconsciousness). Long-term toxic effects are documented for many of the compounds although target organs and symptoms are varied and specific for each compound.

2.2 Physical Hazards

Physical hazards related to this task include personnel working with or in close proximity of heavy equipment, excavations, use of power tools, confined spaces, falling objects, and heat stress. Personnel need to be cognizant that the use of personal protective equipment may reduce dexterity and visibility and increase the difficulty of performing some tasks. Physical hazards

may be controlled through the use of equipment guards, work practices, and training. Only equipment that is used for its intended task and that is in safe operating condition will be used. Personnel will be trained in the proper use and safe operation of the tools and equipment they utilize.

3.0 TRAINING

All personnel performing fieldwork for this task will have completed the forty (40) hour hazardous waste operations health and safety training pursuant to 29 CFR 1910.120(e) before beginning work. Eight (8) hour annual refresher training is required as necessary. The MK Construction Manager and subcontractor supervisor are required to have completed eight (8) hour Hazardous Waste Operations Supervisor/Manager training prior to the beginning of fieldwork.

Task/site specific training regarding the following topics will be given to all personnel performing fieldwork:

- ° Name of Site Safety and Health Supervisor and alternate.
- ° Safety and Health hazardous related to this task.
- ° PPE requirements.
- ° Work practices.
- ° Hazard control.

- ° Medical surveillance requirements, including recognition of signs and symptoms which might indicate overexposure to chemical hazards.
- ° Decontamination procedures.
- ° Emergency response.
- ° Confined space entry procedure.

MK and each subcontractor shall have at least two workers at the site with valid certification in first-aid/CPR training from the American Red Cross (or equivalent).

4.0 MEDICAL SURVEILLANCE

The basic requirements of the RMA Project Medical Surveillance Program shall apply to implementation of this task. No additional medical surveillance requirements are necessary.

5.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

The PPE to be utilized during NWBS Short-Term Improvements is dependent upon the specific task to be performed, the potential for contacting potentially contaminated soils or groundwater, and the concentration of air contaminants in the breathing zone of project personnel. The following PPE will be utilized (modified, as necessary, by the level of air contaminants measured in the

breathing zone or at the discretion of the Site Health and Safety Officer).

<u>Task</u>	<u>PPE Level</u>
Well Drilling	Modified C
Excavate Bench	D
Deep Trenching	Modified C
Backfill Bench	D
Piping in Bench	D
Piping in Trench	D
Piping Tie-in in Vault	D
Underground Electrical	D
Electrical in Bench Area	D
Ground Level Electrical Control Stations	D
Install New Electrical Cabinet in Plant	D

5.1 Level D Personal Protective Equipment:

- ° PVC/Polyurethane steel-toed boots
- ° Cotton Coveralls
- ° Hard hats
- ° Safety glasses with side shields

5.2 Level C Modified Personal Protective Equipment:

- ° PVC/Polyurethane steel-toed boots
- ° Cotton Coveralls (inner)
- ° Poly-ethylene-coated Tyvek coveralls (outer)
- ° Hard hats
- ° Safety glasses with side shields

- ° Latex gloves (inner)
- ° Nitrile gloves (outer); Leather gloves may be worn outside of the nitrile gloves, but must remain on site at all times and be disposed of with other disposable clothing at the conclusion of the task.

5.3 Level C Personal Protective Equipment

- ° PVC/Polyurethane steel-toed boots
- ° Cotton Coveralls (inner)
- ° Poly-ethylene-coated Tyvek coveralls (outer)
- ° Hard hats
- ° Latex gloves (inner)
- ° Nitrile gloves (outer); Leather gloves may be worn outside of the nitrile gloves, but must remain on site at all times and be disposed of with other disposable clothing at the conclusion of the task.
- ° Full-face air-purifying respirator with GMC-H cartridges (or equivalent).

6.0 SAMPLING/MONITORING

Sampling/monitoring will be performed to assess the exposure of personnel to hazardous materials and substances and to ensure that the proper level of personal protective equipment has been selected. Monitoring will also be conducted to delineate areas where protection is needed.

Air monitoring will be performed using direct-reading real-time instruments. Direct-reading instruments will be calibrated daily before use according to the manufacturer's instructions. The following table describes the appropriate response action for the detection of organic vapors. A flame-ionization detector (Foxboro Century OVA-128 or equivalent) will be used to monitor organic vapors. Monitoring will be performed periodically, as necessary.

Concentration in Breathing Zone*

Required Response

Less than 2ppm

- 1) Level D or Modified Level C PPE.
- 2) Continue monitoring, as necessary.

Greater than 2ppm,
Less than 20ppm

- 1) Upgrade to Level C PPE
- 2) Increase frequency of monitoring.
- 3) Determine extent of airborne levels, modify extent of exclusion zones as necessary.

Greater than 20ppm

- 1) Cease disturbing contaminated material, evacuate area.
- 2) Notify Construction Mgr. and H&S Mgr.

- 3) Determine extent of
 airborne levels,
 modify extent of
 exclusion zones as
 necessary.

* For five consecutive minutes; these levels are concentrations above background.

Air sampling using NIOSH or OSHA methodology will be performed at the discretion of the Site Health and Safety Officer.

7.0 SITE CONTROL

An exclusion zone will be established for each task where Level C-Modified PPE (or greater) is required. Entry into the exclusion zone is restricted to those personnel wearing the appropriate personal protective equipment. For the task of well drilling, the exclusion zone will be a minimum of 25 feet in all directions around the drill rig. The exclusion zone for the deep trenching operation will be the side of the working bench where the deep trench spoils are placed. The exclusion zone will be conspicuously demarcated through the use of orange traffic cones, or other equally suitable means. The Site Health and Safety Officer has at his/her discretion the authority to increase the size of the exclusion zone, if necessary, or to establish and exclusion zone for any of the other tasks.

RMA REMEDIATION PROJECT IRA FINAL DETAILED DESIGN
NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS
SPECIFICATION SCHEDULE

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2. 34-0203 Excavating and Backfilling
3. 34-0262 Soil Bentonite Slurry Cutoff Trench
4. 34-0270 Dewatering Wells
5. 34-0272 Alluvial Monitoring Wells
6. 34-0301 Cast in Place Concrete
7. 35-1501 Piping and Instrumentation
8. 37-1601 Electrical Work
9. 37-1621A Pole Mounted Transformer

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SPECIFICATION 34-0202

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

SITE PREPARATION AND GRADING

CLIENT: SHELL OIL COMPANY

PROJECT: NORTHWEST BOUNDARY SYSTEM

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION SECTION 34-0202

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

SITE PREPARATION AND GRADING

1. SCOPE

- A. This specification and other Contract Documents cover the furnishing of all equipment, labor, materials, and performance of work for site preparation, grading, and incidental items as required by applicable drawings and as specified herein.
- B. Generally, required items of work include:
 - 1) Established line and elevation control.
 - 2) Locating and protecting existing underground pipelines.
 - 3) Incidental items.

2. RELATED WORK

- A. The following related work is covered in other specifications:
 - 1) Excavating and backfilling for manholes and underground piping; maintaining temporary roads during subsequent activities; finish grading.

3. GENERAL PROCEDURES

- A. Reference Points: Carefully maintain bench marks, monuments and other reference points. Replace them as the Engineer directs if they are disturbed or destroyed.
- B. Soil Investigation: Refer to Drawing 34-001 for information on site borehole well locations. Detailed borehole logs are available for review at the Engineer's office in downtown Denver.
- C. Inspector: The services of a qualified Inspector will be provided by the Engineer to determine by observation and testing the quality of work and materials during site preparation and grading. He will judge the adequacy of site preparation, acceptability of available fill material, and the correct placement and compaction of fill. Work procedures require his approval as they are successively

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performed. Any work found unsatisfactory shall be corrected in an approved manner at the Contractor's expense.

4. INSPECTION

- A. All materials and the work shall be subject to inspection by the Engineer. The Engineer shall be provided access to all parts of the work and shall be furnished with such information and assistance as is required to make a complete and detailed inspection.
- B. The Engineer may direct that portions of the work be removed or uncovered. After examination, said portions of the work shall be restored to the standard required by these specifications.
- C. Do not proceed with the work until lines, grades, and/or structure locations have been established. Any work performed contrary to the drawings, specifications, or instructions of the Engineer, beyond the line and grades shown on the drawings, or any extra work done without authorization of the Engineer, may be ordered removed or replaced, at the Contractor's expense.

5. GRADING

- A. General: Perform necessary grading to achieve final elevations closely approximating those shown by the drawings. Surfaces shall be well-compacted, reasonably smooth, and free from irregularities, with uniform transitions made to adjacent areas.
- B. Ditches and Swales: Finish to drain readily. Take measures to prevent erosion of freshly graded areas by appropriate means before vegetation is re-established. Repair and reestablish areas of settlement or erosion to required elevations and slopes prior to acceptance of the work.
- C. Road Subgrades: New permanent roads are not required nor provided. New 2" PVC underground pipe shall be installed in a trench that will be cut across a gravel road which is used to service the wells. After the pipe is installed and tested, and the trench is properly backfilled and compacted, restore the road to near original crown, grade, and surface materials.

6. INCIDENTAL ITEMS

- A. Safeguards: Provide, erect, maintain, and later remove temporary safeguards such as barricades, guard rails, signs, lights, and flares for protection of personnel, the public, equipment, and materials, as the Engineer directs and as required by state, federal, and local codes and ordinances.

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B. Existing Underground Lines and Services:

- 1) The Owner will provide the approximate location of existing underground lines and services. The Contractor is responsible for verifying the location of, uncovering, and protecting these items.
- 2) Do not cut, remove or damage these items unless directed to do so by prior written approval of the Engineer.
- 3) Lines or services damaged will be repaired or replaced to the Engineer's satisfaction at the Contractor's expense.

C. Water Removal: Maintain grades to promote water drainage. Provide and operate equipment to keep construction areas free of surface and storm water. Provide necessary diversion ditches or other Engineer approved facilities for removing water. Dispose of surface and storm water as directed by the Engineer so construction and storage areas, streets, roads, and other surfaces are not flooded.

D. Temporary Roads: Locate and construct temporary roads at locations directed or approved by the Engineer to serve as a means of access during construction activities.

E. Stripping Topsoil: In excavated areas, the top 8 to 12 inches of soil shall be separately excavated and stockpiled for later use in providing the top layer of backfill.

F. Finish Grading: Spread soil from on-site stockpiles onto previously stripped areas, including the working bench, that have been rough graded. Select materials to eliminate large stones, vegetation, and debris. Spread soil smoothly and uniformly, in sufficient quantity to allow for natural settlement, so that final dressing can be performed satisfactorily. Raking or compacting is not required.

G. Revegetation: Revegetation is not required nor provided under this specification.

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SPECIFICATION 34-0203

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

EXCAVATING AND BACKFILLING

CLIENT: SHELL OIL COMPANY

PROJECT: NORTHWEST BOUNDARY SYSTEM

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION 34-0203
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA
EXCAVATING AND BACKFILLING

1. SCOPE

- A. This specification and other Contract Documents cover the furnishing of all equipment, labor, materials and performance of work for all excavating, backfilling and incidental items as required by applicable drawings and as specified herein.
- B. Generally, required items of work include:
 - 1) Excavating for structures and preparing subgrades for manholes
 - 2) Excavation for the working bench
 - 3) Filling, backfilling and compacting
 - 4) Grading around structures
 - 5) Incidental items

2. RELATED WORK

- A. The following related work is covered in other specifications:
 - 1) Site Preparation and Grading (Specification 34-0202)
 - 2) Piping and Instrumentation (Specification 35-1501)
 - 3) Soil-Bentonite Slurry Cutoff Trench (Specification 34-0262)

3. GENERAL PROCEDURES

- A. Reference Points: Carefully maintain bench marks, monuments and other reference points. Replace items as the Field Engineer directs if they are disturbed or destroyed.
- B. Soil Investigation: A report of soil conditions investigated on the site is shown on the drawings. Accuracy of this report is not

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guaranteed in that conditions at the present time and at other locations on the site may vary from those disclosed.

- C. Engineer: The Engineer will determine by observation and testing the quality of work and materials during excavating and backfilling. He will judge: acceptability and advantageous use of available fill and backfill materials; and the correct placement and compaction of fill and backfill to specified densities. Excavating, filling, backfilling and compacting procedures require his approval as they are successively performed. Any work found unsatisfactory shall be corrected in an approved manner.

4. EXCAVATING FOR STRUCTURES

- A. Dimensions: Excavate to required elevations and dimensions, allowing ample space for form and material placement, inspection, and form removal. If the nature of the soil permits and the Engineer gives prior approval, excavation may be made to correct dimensions and used as a concrete form. Degree of slope for open cut earth banks in all excavations over 5 feet deep in which a man enters will be as outlined in the Task-Specific Health and Safety Operating Procedure.
- B. Removing Materials: Excavate all materials encountered, except for existing services and permanent structures. Remove rock, boulders, portions of abandoned structures, and other hard obstructions to a depth at least 6" below planned excavation level in the pressure pipe trench. Soil conditions at bottom of excavation shall be subject to the Engineer's approval. Surfaces shall be level, or sloped as required, clean, and clear of mud or frozen material.
- C. Suitable Bearing: Where unsuitable material is exposed at completion of planned excavation, perform further excavation as directed by the Engineer until suitable bearing is reached. Place and compact fill as specified herein to correct elevations.
- D. Overexcavation: If materials are removed below required elevations, through error or careless excavating, the Contractor shall notify the Engineer who will determine corrective measures. MK-ES Construction Manager shall determine if the Contractor is due additional compensation.
- E. Rock Excavation:
- 1) Rock is defined as stone or hard shale in original ledge, and boulders over 1/2 cu.yd in volume or over 3'-0" in greatest dimension, which require special equipment and/or explosives to remove.

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- 2) It is assumed that materials at the job site can be excavated with normal equipment such as a power shovel, bulldozer, or hydraulic excavator. If rock is encountered, notify the Engineer for his consideration before proceeding with further excavating.

F. Material Storage and Disposal: Select excavated materials which can be reused later shall be classified and stockpiled. Dispose of other unsuitable and excess material and debris elsewhere on the Owner's property as directed by the Engineer.

G. Existing Underground Lines and Services:

- 1) The Engineer will provide the approximate location of existing underground lines and services. The Contractor is responsible for verifying the location of, uncovering, and protecting these items.
- 2) Do not cut, remove or damage these items unless directed to do so by prior written approval of the Engineer.
- 3) Lines or services damaged will be repaired or replaced to the Engineer's satisfaction at the Contractor's expense.

5. WORKING BENCH

A. General: The working bench shall be constructed to the elevations, lines, grades, and cross-sections shown on the drawings and in accordance with these specifications, unless otherwise directed by the Engineer. The Engineer may modify the dimensions and quantities of the work as determined to be necessary. Excavation of the slurry trenches shall be performed from this working bench.

B. Excavation: Approximately 10 ft of existing alluvium will be excavated down to the elevation shown on the drawings and establish a working bench to minimize trench depth and create an area to stockpile potentially contaminated soils from the slurry trench excavation. The width and any special configuration of the bench shall be as depicted on the drawings. Contaminated soils will be designated by the Field Engineer. Potentially contaminated or contaminated soils will be stored on the working bench. If any contaminated or potentially contaminated soil must be removed from the working bench, it will be drummed by the Contractor in drums provided by the Engineer or handled as otherwise approved by the Engineer. The Engineer will be responsible for arranging for characterization, storage, and final disposal of drummed soil as required. Potentially contaminated soil will be stockpiled on one side of the benched platform to isolate the material. Handling procedures shall be in accordance with the project Task-Specific

Health and Safety Plan. The height of stockpiled material shall not exceed the existing ground level adjacent to the working platform.

6. FILLING, BACKFILLING AND COMPACTING

- A. Fill and Backfill Materials: Use Engineer approved materials obtained from stockpiles of excavated material, borrow areas, or off-site locations. Provide suitable fill free of debris, organic material and large rocks; frozen matter; and excessive moisture or dryness.

1) All Other Fill and Backfill: Use clean earth.

B. Placing Fill and Backfill:

- 1) Working Bench: Material excavated from the slurry cutoff trench stockpiled on the working bench shall be spread over the working bench to an approximately uniform depth and compacted. The remaining depth to ground surface shall be backfilled with compacted uncontaminated alluvium excavated from the working bench during trench construction activities following a 14-day stabilization period for the trench backfill slurry. The working bench will be compacted in accordance with paragraph 6.C.1 below. Equipment traffic and other activity shall not be allowed on top of the covered slurry trench until the area has been allowed to stabilize for at least 14 days. Ground elevation surveys completed after installation of the bench backfill and at weekly intervals during the stabilization period will be used to determine if subsidence has occurred. Cavities in the platform backfill formed during the 14-day stabilization period shall be backfilled and compacted with indigenous alluvium to maintain the grade of ground surface. An additional 14-day stabilization period will be put into effect if significant subsidence occurs.

- 2) The pressure pipe trench shall be bedded and backfilled as described in Specification 35-1501, "PIPING AND INSTRUMENTATION."

C. Compacting:

- 1) Native backfill shall be compacted to 80% of standard Proctor density.
- 2) Backfill across the gravel well service road will be compacted to 95% of standard Proctor density.

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7. GRADING

- A. General: Perform necessary grading to achieve final elevations closely approximating pre-existing conditions. Surfaces shall be well compacted, reasonably smooth and free from irregularities, with uniform transitions made to adjacent areas. Raking and reseeded will be provided by others.

8. INSPECTION

- A. All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Engineer shall be provided access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.
- B. The Engineer may direct the Contractor to remove or uncover portions of the work. After examination, the Contractor shall restore said portions of the work to the standard required by these specifications.
- C. The Contractor shall not proceed until the lines, grades and/or structure locations have been established. Any work done by the Contractor contrary to the drawings, specifications or instructions of the Engineer, beyond the lines and grades shown on the drawings, or any extra work done without authorization of the Engineer, may be ordered removed or replaced at the Contractor's expense.

9. INCIDENTAL ITEMS

- A. Safeguards: Provide, erect, maintain and later remove temporary safeguards such as barricades, bridges, guard rails, signs, lights and flares for protection of personnel, the public, equipment and materials as the Engineer directs and as required by state and local codes and ordinances.
- B. Retaining Excavations: Provide shoring, sheeting and bracing necessary to retain excavations, maintain banks securely, withstand water pressure, prevent cave-ins, and protect life and property. As backfilling proceeds, remove shoring, sheeting and bracing in a manner to prevent damage or disturbance to the construction and surrounding areas.
- C. Water Removal: Maintain grades to promote water drainage. Provide and operate equipment to keep construction areas free of surface and storm water. Provide necessary diversion ditches or dewatering systems. Dispose of surface and storm water as directed by the Engineer so construction and storage areas, streets, roads and other surfaces are not flooded. Do not remove any groundwater from an

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excavations except for water attached to the in-place soils to be excavated.

- D. Temporary Roads: Maintain temporary roads in operating condition.
- E. Access: Appropriate fencing and/or barricades will be installed to restrict access to the trench area during stabilization. Surveying and fencing and/or barricades will be provided by the Engineer.

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SPECIFICATION 34-0262

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

SOIL-BENTONITE SLURRY CUTOFF TRENCH

CLIENT: SHELL OIL COMPANY

PROJECT: NORTHWEST BOUNDARY SYSTEM

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION 34-0262
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA
SOIL-BENTONITE SLURRY CUTOFF TRENCH

1. SCOPE

- A. The work consists of furnishing plant, labor, equipment, and materials and of performing operations as required to construct the slurry cut-off trench as specified on drawings and in the following paragraphs.

2. RELATED WORK

- A. The following related work is covered in other specifications:

1) Site Preparation and Grading (Specification 34-0202)

3. REFERENCE STANDARDS

- A. Organizations whose standards are referenced herein include the following:

- 1) ASTM - American Society for Testing and Materials
2) API - American Petroleum Institute
3) CE - Corps of Engineers

4. QUALIFICATION OF CONTRACTOR

- A. Experience: The Contractor shall submit evidence to the Engineer that he is competent to construct a soil-bentonite slurry trench. This evidence should insure that the Contractor will have sufficient experienced personnel to carry out the operations specified. The Contractor qualifications should include extensive trenching experience including some deep trenching construction.
- B. Slurry Trench Specialist: A Slurry Trench Specialist (as approved by the Engineer) shall supervise the construction, slurry preparation, and quality control. The Slurry Trench Specialist shall have knowledge and be experienced in slurry trench construction. This experience should include, but not necessarily be limited to:
1) the use, testing and control of bentonite as a slurry; 2) the

mixing methods required to properly mix the bentonite and backfill slurries required; 3) trench excavating and backfill procedures; and 4) knowledge of construction equipment and materials testing as required for slurry trench construction. The Slurry Trench Specialist shall control the mixing, composition, placement, cleaning and maintenance of the bentonite and backfill slurries. The Slurry Trench Specialist shall supervise and ensure that the trench is vertical, properly aligned and cleaned prior to placement of the backfill slurry. The credentials of the Slurry Trench Specialist shall be submitted to the Engineer three weeks prior to starting trench construction.

- C. Hazardous Waste Training: Contractor personnel shall have sufficient safety training approved by the Engineer. Training shall include the OSHA 40 hour course under 29 CFR 1910.120.

5. SLURRY TRENCH CUTOFF

- A. Description: A slurry trench cutoff wall having low hydraulic conductivity shall be constructed to the lines, grades, and cross sections as indicated on the Drawings. The trench shall have essentially vertical walls, a nominal width of 36 inches, and shall extend through unconsolidated alluvium and key a minimum depth of five feet into the underlying Denver Formation or refusal as determined by the Engineer. Excavation will continue should the upper portion of the Denver Formation be composed of soft, easily excavated sand or sandstone as directed by the Engineer into the Denver Formation until consolidated strata are encountered. Cutoffs into the Denver Formation shall be constructed so that undue interruptions of trench excavation and backfilling do not occur.
- B. Method of Construction: A working bench shall be excavated to the elevation and grades shown on the drawings along the centerline of the proposed slurry trench. Excavation of the slurry trench shall be performed from this working bench. The working bench concept is depicted on drawings accompanying this specification.
- C. Trench Specifications: The trench shall be excavated to total depth at the point where excavation is started. The Contractor shall maintain the stability of the excavated trench at all times for its full depth. The sides of the trench shall be maintained from collapsing by keeping the trench filled with a bentonite slurry during excavation and prior to backfilling. The bentonite slurry will be displaced by a backfill slurry consisting of bentonite, fines and soil. The backfill slurry will solidify to form the cutoff. The solidified slurry shall have a hydraulic conductivity approximating 1×10^{-7} cm/sec. The cutoff shall extend to the surface of the working bench. The cutoff shall be covered with a 2 ft thick

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clay cap and the working bench backfilled with native alluvial material.

- D. Excavation Depth: The Contractor shall be responsible for documenting that the slurry trench is vertical, continuous and that the Denver Formation is penetrated to the minimum depth required. The Contractor shall verify that adequate excavation depth has been achieved by taking soundings at least every 10 ft along the trench or when directed by the Engineer. The Contractor shall have a split-spoon sampler available.

6. GEOTECHNICAL SITE CONDITIONS

- A. Exploratory Borings: Boreholes have been drilled by the Engineer to determine the character of materials to be excavated. Borehole locations and geologic conditions encountered near the proposed trench site are identified on the plans. The Engineer assumes no responsibility for interpretation or deductions made by the Contractor from the logs and borings. Local variations in the subsurface materials are to be expected.
- B. Subsurface Conditions: Bore hole information, available from the engineer, indicates that material at the site consist of alluvial silts and sands, with some gravels, which generally become more permeable with depth.
- C. Groundwater: The water table occurring during April 1990 is shown on Drawing 34-001. Monitoring shows temporal water table variations to be slight. Well production of several gpm is possible from 4-inch diameter wells constructed in the area.

7. SUBMITTALS

- A. General: The Contractor shall submit data for approval by the Engineer for items required by this section.
- B. Schedule and Sequence of Operations: The Contractor shall submit a schedule and sequence of operations. This shall include but not necessarily be limited to, 1) excavating schedules; 2) use of excavated material; 3) waste management; 4) slurry preparation; 5) slurry placement; 6) bottom cleaning; 7) backfill preparation; 8) trench backfill; and 9) closure.
- C. Layout of Operations: The Contractor shall submit a layout of operations. The layout of operations shall include, but is not necessarily limited to drawings depicting 1) bentonite storage area(s); 2) slurry preparation area(s); 3) hydration pond(s); 4) slurry storage area(s); 6) backfill storage area(s); 7) backfill mixing area(s); 8) location and sizes of stationary equipment; 9)

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water storage tanks, pumps, valves, lines hoses and materials; and
10) waste area(s).

- D. Slurry Trench Construction Method and Equipment: A description of the proposed method of construction of the soil-bentonite slurry cutoff trench including excavation site plan, and a listing of the Contractor's available equipment shall be submitted to the Engineer for approval prior to construction.
- E. Material Certification: A certificate describing the chemical and physical properties of the bentonite proposed for use in trench construction shall be submitted to the Engineer for approval prior to construction.
- F. Mix Design: Mix reports for backfill including moisture content, density, mix proportions and gradation shall be submitted to the Engineer for approval prior to construction.
- G. Excavation and Backfill Soundings: A description of the method to be used by the Contractor to determine trench depths shall be submitted to the Engineer for approval prior to construction.
- H. Quality Control Testing Equipment and Procedure: Methodology proposed to perform required quality control tests (see attached Table) shall be submitted to the Engineer for approval prior to construction.

8. MATERIALS

- A. Bentonite Slurry: The bentonite slurry is required to support excavation walls during construction, prior to installation of the backfill, and to create a filter cake along excavation walls to minimize slurry loss from the trench. The slurry shall consist of a stable colloidal suspension of bentonite in water. Slurry properties shall be determined by API (American Petroleum Institute) Specification R.P. 13B (Recommended Practice Standard Procedure for Field Testing of Drilling Fluids). The properties of the bentonite slurry may be altered to suit construction conditions through the use of additives, subject to the prior approval of the Engineer. No peptizing or bulking agents shall be used as additives to the bentonite slurry. The bentonite slurry shall have sufficient density and viscosity to support the trench walls without excessive slurry infiltration into the alluvium. The slurry shall be mobile enough to be displaced by the backfill slurry when necessary and to fill voids in the trench walls. The bentonite slurry shall be stable and not flocculate out of solution. The pH of the bentonite slurry shall be 7 ± 1 . The quantity of bentonite used in preparing the bentonite slurry will be dependent upon the grade of bentonite the Contractor proposes to use. Approval of the Engineer is required regarding both

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the grade of bentonite proposed for use and the proposed bentonite to water mixture. No bentonite slurry shall be mixed by hand or in the trench.

- B. Backfill: The backfill is a mixture of bentonite, soil and water. This slurry solidifies to form the cutoff wall. The backfill slurry shall be composed of bentonite slurry mixed with selected materials excavated from the trench and/or materials transported from approved borrow areas. It shall contain at least 20% by weight of material passing U.S. Standard #200 sieve, and 100% passing a 1½" sieve. The backfill slurry shall be well mixed and shall not contain organic matter, roots or other deleterious matter. The backfill slurry shall be thoroughly mixed into a homogeneous mass, free of lumps of clay and silt and pockets of sand and gravel. The gradation of the backfill will be determined according to ASTM (American Society for Testing and Materials) D422-63. The gradation and bentonite content of the backfill will be determined for each 300 cubic yards of slurry.

C. Bentonite Slurry Requirements

- 1) Density: The density of the bentonite slurry shall be monitored and controlled by the Contractor so that: trench stability is maintained; slurry infiltration minimized; and slurry displacement of the backfill assured. A minimum density of 65 #/ft³ is required at the slurry mixing station(s). A maximum density of 100 #/ft³ is allowed within the trench. The density of the bentonite slurry shall be determined at least twice daily. The density shall be determined as specified in API Specification 13A (1989) (Specifications for Oil Well Drilling Fluid Materials).
- 2) Viscosity: The degree of hydration shall be determined through evaluating the apparent viscosity of the slurry. A Marsh funnel shall be used for evaluating viscosity. An acceptable slurry shall require a minimum of 40 seconds (viscosity greater than 15 centipoise) for an American quart of slurry to flow through the Marsh funnel. The viscosity of bentonite slurry within the trench shall also conform to this requirement. Viscosity shall be determined twice daily. The viscosity shall be determined as specified in API Specification 13A (1989).
- 3) Filtrate: Filtrate loss shall be evaluated to determine the degree of slurry hydration. A filter press shall be used to evaluate filtrate loss. Slurry samples shall be subjected to a constant pressure of 100#/in² for 30 minutes and the amount of resulting filtrate monitored. Values of 15-30 cm³ of filtrate shall be considered acceptable. Slurry filtrate loss

shall be determined as specified in API Specification 13A (1989).

- 4) Hydration: Slurry hydration shall be completed prior to placement of the bentonite slurry into the trench. Degree of hydration shall be determined through evaluating the density and viscosity of the slurry.

D. Backfill Requirements

- 1) General: Backfill materials shall be thoroughly mixed and sluiced with bentonite slurry to form a homogeneous mass prior to placement into the trench. The backfill slurry shall be mixed by windrowing, disc harrowing, bulldozing or blading. A gradation test shall be performed for every 300 cubic yards of slurry added to the trench. Mixing with additional dry bentonite powder is allowable, subject to approval of the Engineer, if required to approximate the design hydraulic conductivity.
- 2) Slump Testing: Slump testing of the mixed backfill slurry shall be conducted as the backfill is added to the trench. Testing will be conducted according to specifications described in ASTM C-143. Two tests per day shall be performed. Additional testing as specified by the Engineer may also be required. A slump of 3 to 6 inches shall be considered acceptable.
- 3) Hydraulic Conductivity: Hydraulic conductivity tests shall be made on samples of the backfill taken just prior to placement in the trench. Samples for hydraulic conductivity tests will be collected for each 200 ft. of trench with the first sample being taken of the initial batch of backfill. Hydraulic conductivity testing shall be by flexible membrane or fixed ring equipment or a contractor proposed method approved by the Engineer, and in accordance with ASTM D-1587. Information collected will be used for historical data.

- E. Bentonite: The bentonite shall be sodium cation base montmorillonite powder (Premium Grade Wyoming-type bentonite) that conforms to the standards set forth in API Specification 13A, Section 3, 5, 6, 7, and 8 as last revised. No chemically treated bentonite will be allowed. The Contractor shall furnish to the Engineer a certificate of compliance and a copy of the test reports from the bentonite for each lot or bentonite shipped to the site stating that the bentonite complies with all applicable standards. No bentonite from the supplier shall be used prior to acceptance by the Engineer. All bentonite will be subject to inspection, sampling, and verification of quality of testing by or under the supervision of the Engineer.

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Bentonite not meeting specifications shall be promptly removed from the site and replaced with bentonite conforming to specification requirements of the Engineer. Bentonite shall be protected from moisture during transit and storage. The Contractor shall specify the grade of bentonite he proposes to use during trench excavation, for approval by the Engineer.

- F. Water: The water used in preparing the slurry and backfill trenches shall approximate fresh and potable water. The water shall be free from oil and excessive amounts of acid, alkali, organic matter and other deleterious substances. Potential water sources, identified by the Engineer, shall be tested prior to beginning trench excavation to assure water will be of suitable characteristics for slurry preparation and will not adversely affect the swelling of bentonite. Water used in preparing the bentonite slurry and soil-bentonite/slurry shall have a pH of between 7 \pm 1. The water shall contain no more than 750 mg/l total dissolved solids. The Contractor will determine the specific conductivity, hardness and pH of water used in slurry preparation each morning. A water's total dissolved solid content is generally between 0.55 and 0.75 x of its specific conductivity. Total hardness shall not exceed 150 mg/l.
- G. Additives: Admixtures of softening agents, dispersants, retarders, or plugging or bridging agents may be added to the water or the slurries to permit efficient use of bentonite and proper workability of the slurries. No additives shall be used except as approved by the Engineer.
- H. Soil: It is believed sufficient indigenous alluvial material will be available from trench and/or working bench excavation to supply required quantities.

9. EQUIPMENT

- A. Trench Excavation: Excavation of the slurry trench cutoff wall shall be accomplished by use of approved earth-moving equipment or combination thereof such as backhoe and/or clamshell so that the required width trench can be carried to its final depth of cut continuously along the trench line. Special chopping, chiseling, or other suitable equipment may be used as necessary to satisfactorily accomplish the required excavation. The width of the excavating tool shall be equal to or greater than the specified width of the cutoff wall. The trench bottom will be cleaned and prepared prior to introduction of the backfill slurry by an approved method.
- B. Slurry Batching Plant: The slurry batching plant shall include the necessary equipment including a mixer capable of producing a stable suspension of soil in a bentonite and water slurry, pumps, valves, hoses, supply lines and other equipment as required to adequately

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supply slurry to the trench. Slurry for use in the trench shall be prepared using a suitable mixer. No slurry shall be prepared in the trench. Bentonite slurry shall be prepared by mixing water and bentonite until the bentonite particles are fully hydrated and the resulting slurry appears homogeneous. Storage ponds may be used to hydrate the bentonite slurry.

10. EXECUTION OF THE WORK

- A. Slurry Trenching: Excavation shall be carried to final depth at the point where excavation is started and then the final depth of cut shall be carried along the line of the trench in a continuous operation. The new slurry trench shall be constructed to overlap the existing slurry trench a minimum of 10 ft for the full depth of the slurry trench. Slurry shall be introduced into the trench at the same time trenching is begun and shall be maintained in the trench during excavation. The Contractor shall maintain the stability of the excavated trench at all time for its full depth. The level of the slurry shall not be permitted to drop more than two feet below the surface of the slurry trench working bench except as approved by the Engineer. The level of the slurry shall be maintained a minimum of 3 ft above the water table. The Contractor shall have personnel, equipment, and materials ready to raise the slurry level at any time. To this end, the Contractor shall have personnel on call to raise the slurry level, weekends and/or holidays included.
- 1) Excavated Material: Contaminated soils will be designated by the Field Engineer. Potentially contaminated or contaminated soils will be stored on the working bench. If any contaminated or potentially contaminated soil must be removed from the working bench, it will be drummed by the Contractor in drums provided by the Engineer. The Engineer will be responsible for arranging for characterization, storage, and final disposal of drummed soil as required. Potentially contaminated alluvium will be stockpiled on one side of the benched platform to isolate the soil removed during the trenching operation. Personnel working on this side of the trench will follow the Engineers directions in accordance with the project Health and Safety Plan. The height of stockpiled material shall not exceed the existing ground level adjacent to the working platform.
 - 2) Water Table: Excavation shall cease and the trench be backfilled if the water table should rise to within 3 ft of the working platform and a continued rise appears evident. Excavation may again proceed when the water table recedes to an acceptable elevation as determined by the Engineer. The Contractor shall reexcavate the backfill where it does not meet

standards due to the rising water table. The Contractor shall reexcavate a segment of the placed backfill of design specifications prior to reinitiating trench excavations to allow interconnection with new backfill.

- 3) Cleaning: If necessary, the bentonite slurry in the trench shall be cleaned prior to placement of the backfill slurry to remove soil particles which may have collected in the slurry. The slurry cleaning shall be accomplished by airlifting the slurry to the surface and subsequent circulation through desanding units or other suitable method approved by the Engineer. The slurry cleanup shall result in a bentonite slurry having a viscosity which will allow displacement by the backfill slurry.

B. Backfill Placement

- 1) Backfill Characteristics: The backfill slurry shall be mixed by windrowing, disc harrowing, bulldozing or blading to meet the required gradation. Slurry mixing will be conducted along the working bench to the extent possible. Uncontaminated material shall be used in preparing backfill slurry mixed outside of the working platform in areas approved by the Engineer.
- 2) Equipment: Equipment used in mixing the backfill can consist of earth moving or grading equipment such as bulldozers, barrows, and blade graders. A vibratory shaker screen shall be used to remove excess sand and sediment from the backfill if necessary. The backfill shall be placed into the trench using bulldozers and/or a crawler crane equipped with a clamshell bucket.
- 3) Bottom Cleaning: The trench bottom shall be cleaned of gravel, sand and other sediment which may settle out of bentonite and backfill slurries. A jetting pipe, air lift pump or other suitable method approved by the Engineer may be used.
- 4) Backfill Placement: The backfill slurry shall be placed continuously from the beginning of the trench in the direction of excavation to the end of the excavation. Placement shall proceed in such a manner that the top of the backfill below the surface of the trench follows a reasonably smooth grade without hollows which may trap pockets of slurry during subsequent backfilling. Free dropping of backfill through the bentonite slurry will not be permitted. Initial placement of the backfill shall be by lowering it to the trench bottom using a crane and clamshell bucket as necessary until the surface of the backfill slurry rises to the trench surface at the

excavation terminus. Additional backfill slurry shall then be placed by bulldozer in such a manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill slurry. The slope produced by the backfill shall range between 1 to 5 and 1 to 10 vertical to horizontal.

An alternative would allow the Contractor to initiate excavation outside the designated work area on the northeast end of the new slurry trench. This could provide a sufficient distance for a backfill face to be formed by dozing the backfill into the trench before the toe of the backfill slurry reaches the point, where cutoff is required. Excavation outside the designated work area will be at the Contractor's expense and subject to Engineer approval.

Precautions shall be taken during the initial placement of the backfill slurry to insure that the backfill reaches the trench bottom and assumes a suitable slope. The toe of the backfill slope shall be within 50 to 100 ft of the leading edge of trench excavation to minimize the open length of the trench supported by the bentonite slurry. The physical properties of the bentonite and backfill slurries shall be controlled such that minimal amounts of bentonite slurry are trapped within the backfill. Equipment shall be operated in such a manner that sloughing of alluvium at the trench top does not occur. Backfill operations shall be suspended when the ambient temperature falls below 25°F. A 1-gallon sample of the backfill slurry will be collected for each 200 ft of trench. The samples will be archived for possible future reference.

- C. Key: The bottom of the slurry trench will be keyed the minimum specified penetration into the Denver Formation as directed by the Engineer. The final depth and penetration of the trench shall be measured and checked by the Contractor and approved by the Engineer immediately following excavation.
- D. Continuity Between Trench Segments: At such times that a trench segment is extended where the slurry in the previously excavated trench has settled, the excavation tools will be arranged to re-excavate a minimum three-foot overlap into the end of the previously placed backfill.
- E. Slurry in Trench: If at any time the slurry in the trench begins to become unworkable before excavation is completed to the full depth at the point of excavation, or otherwise becomes unworkable, then sufficient freshly made slurry shall be added to correct the situation. Addition of water to the slurry in the trench shall not be permitted.

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- F. Treatment for Top of Cutoff Trench: After initial settlement of the slurry, the top of the completed cutoff trench shall be checked for decantation. Any free water in the trench shall be removed and the trench shall be filled to within 0.5 feet of the working platform with fresh slurry. After the trench has been topped off and the backfill has settled, but before drying can occur, the cutoff trench shall be capped in accordance with the details shown on the drawings. Open cracks in the top of the slurry due to shrinkage in the setting process shall be filled with fresh slurry.
- G. Cleanup: After completion of trenching, any remaining excavated material and slurry shall be removed and placed in thin lifts along the inside face of the working bench area and the surface shall be cleaned and leveled as directed by the Engineer. Excess slurry shall be disposed of by spreading in thin layers within the working bench as designated by the Engineer. No slurry shall be left in ponds, and ponds shall be pumped dry and backfilled.
- H. Trench Cover/Clay Cap: The top of the completed slurry trench shall be covered by a geotextile fabric extending a minimum of 2' on either side of the trench and a 2-foot thick layer of clay hand compacted in 8" lifts as a protective layer to prevent drying. The trench shall be covered within 72 hours after the backfill reaches the top of the trench. Additional compacted fill shall not be applied for 14 days as backfill material in the trench shall be allowed to settle before being covered with permanent compacted alluvial material.

11. QUALITY CONTROL

- A. The Contractor shall maintain his own Quality Control for the cutoff wall construction under the direction of a qualified slurry trench specialist. Testing requirements are summarized in Table 1 and specified herein. The Contractor shall provide the necessary personnel, laboratory facilities and testing equipment to perform the specified tests.
- B. Trench Continuity and Key: The Contractor shall be responsible for demonstrating, to the satisfaction of the Engineer, that the trench is continuous and keyed the minimum specified depth into the Denver Formation as discussed in Sections 5.A and 10.D herein. Trench continuity shall be assured by the action of movement of the trench excavation equipment such that the digging tools can be passed vertically from top to bottom of the trench as well as moved horizontally along the axis of the trench without encountering unexcavated material. Penetration of the bottom of the trench into the Denver Formation shall be demonstrated by observation of the cuttings removed from the trench and by direct measurement of trench depth to the satisfaction of the Engineer.

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C. Materials

- 1) Bentonite: Certificate of Compliance with the Specifications.
- 2) Bentonite Slurry: See Section 6.C Bentonite Slurry Requirements.
- 3) Water: See Section 8.F.

- D. Documentation: Results of all tests performed in accordance with the specification will be recorded on forms acceptable to the Engineer and signed by the Contractor's Project Engineer. These forms will be available to the Engineer at all times for his inspection. Copies of all forms will be submitted daily to the Engineer for his reference.

12. QUALITY ASSURANCE

- A. Testing: The Engineer may perform quality assurance testing on the slurry and backfill materials using the laboratory and equipment furnished by the Contractor. The testing will in no way relieve the Contractor of the responsibility of performing tests necessary to meet the construction requirements. The Contractor shall provide the equipment and laboratory space to the Engineer on demand and these services shall be considered a subsidiary obligation of the slurry trench construction. Routine testing procedures being conducted by the Contractor shall be available for inspection by the Engineer.
- B. Testing Equipment: The Contractor shall furnish and maintain test equipment necessary to adequately perform the required testing. Procedures shall conform to applicable API and ASTM specifications or other suitable methods as approved by the Engineer. The Contractor shall allow the Engineer access to testing equipment and test results without charge. The testing equipment shall include but not necessarily be limited to 1) Marsh Funnel Viscometer and Measuring Cup (Baroid No. 201 and 202 or approved equal); 2) Sand Content Set (Baroid No. 400-01 or approval equal); 3) CO Cartridge Pressurized Filter Press System (Baroid No. 302-01 or approved equal); 4) Electric Laboratory Mixer; 5) Stop Watch; 6) pH Dispenser with Paper (Baroid No. 625 or approved equal); 7) Mud Balance (Baroid No. 140 or approved equal); 9) Slump Test Mold; and 10) Approved equipment for determining hydraulic conductivity. Test results will be reported to the Engineer within 24 hours of conducting a test.

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TABLE 1 - QUALITY CONTROL TESTS REQUIRED

<u>ITEM</u>	<u>CHARACTERISTIC</u>	<u>FREQUENCY</u>	<u>METHOD</u>
Sounding	Trench Depth	10 ft	--
Water	Specific Conductivity pH, hardness	Each Morning Each Morning	Chemistry Chemistry
Bentonite Slurry	Density Viscosity Filtration Sand Content	Twice Daily Once Daily Twice Daily Twice Daily	API 13A Marsh Funnel Filter Press API 13A
Backfill Slurry	Slump pH Gradation Hydraulic Conductivity Archive	Twice Daily Twice Daily 300 yd ³ 200 ft 200 ft	ASTM C-143 Chemistry -- ASTM D-1587 Grab Sample
Working Bench		Sidewall Sloughing	Daily Surveying

Note: These tests are considered to be the minimum needed and the contractor is still responsible for determining the number and frequency of the testing needed for successful completion of the trench.

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SPECIFICATION 34-0270
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA
DEWATERING WELL

CLIENT: SHELL OIL COMPANY

PROJECT: ROCKY MOUNTAIN ARSENAL REMEDIATION PROJECT

INTERIM RESPONSE ACTION FINAL DETAILED DESIGN

NORTHWEST BOUNDARY SYSTEM IRA

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION 34-0270
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA
DEWATERING WELL

1. SCOPE

- A. Two 6-inch diameter dewatering wells will be constructed along the Northeast end of the slurry trench at the Northwest Boundary. The wells are expected to be approximately 40-50 ft in depth. The Contractor will furnish equipment, labor and materials, and perform operations as required to construct the dewatering wells. Design requirements are presented on Drawing 34-002.

2. RELATED WORK

- A. The following related work is covered in other specifications:
- 1) Cast-in-place Concrete (Specification 34-0301)
 - 2) Site Preparation and Grading (Specification 34-0202)
 - 3) Excavation and Backfilling (Specification 34-0203)

3. REFERENCE STANDARDS

- A. Organizations whose standards are referenced herein include the following:
- 1) ASTM - American Society for Testing and Materials
 - 2) API - American Petroleum Institute

4. CONTRACTOR QUALIFICATIONS

- A. The Contractor shall submit evidence, including drilling experience in the Denver area and a list of available drilling and support equipment to the Engineer, that he is competent to construct a dewatering well of the design provided by the Engineer. This evidence should ensure that the Contractor will have sufficient experienced

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personnel to construct the dewatering wells. A qualified well driller, having current State of Colorado well drilling certification and approved by the Engineer, will supervise the construction including well drilling, casing installation, slurry preparation and installation, pump installation and well completion activities.

5. DEWATERING WELL DESCRIPTION

- A. The dewatering wells will consist of a 13-1/2 inch or larger borehole to total depth. The wells will be completed with 6-inch PVC continuous wire screen and Schedule 40 blank casing with a sand pack, bentonite seal, and cement/bentonite grout seal. A stainless steel 3-3/4 inch diameter submersible pump will be installed. A pitless adapter and discharge line shall be installed at 5 ft below finish grade. A lockable vented well cap and concrete well pad with protective barricades will complete the surface installation at the well.

6. MATERIALS

- A. Blank Casing: The well casing will be new 6-inch Schedule 40 PVC pipe. Joints will be solvent welded together.
- B. Well Screen: The well will be completed with a continuous PVC 80-slot (0.080 inch) wire screen.
- C. Tailpipe: The tailpipe will be made of blank 6-inch Schedule 40 PVC pipe with a solid, one-piece bottom cap or plug.
- D. Pitless Adapter: A commercially manufactured pitless adapter suitable for installation in the dewatering well shall be used (MAASS 6JC1 [DW-16] and 6JC1½ [DW-17] or approved equal).
- E. Pump Column: Schedule 80, PVC pipe with threaded PVC couplings will be used as pump columns.
- F. Holddown Pipe: Schedule 80, PVC pipe will be used.
- G. Centralizers: Stainless steel or PVC with stainless steel hardware centralizers will be used.
- H. Pump: A nominal 4-inch submersible stainless steel pump will be installed in the dewatering wells. (See Drawing 34-002 for Model)

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- I. Sand Pack: The sand pack will consist of washed silica sand as produced by Colorado Silica Sand or approved equal. It is anticipated that 6/9 sand will be used. Sand pack characteristics may be changed by the Engineer dependent upon subsurface geologic conditions.
- J. Bentonite: Bentonite used shall be sodium cation base montmorillonite, premium grade Wyoming-type bentonite, which conforms to the most recent applicable API specifications. The Contractor shall furnish to the Engineer a certificate of compliance. Bentonite will be protected from moisture during transit and storage.
- K. Water: A source of water for use during drilling operations will be identified by the Engineer.
- L. Protective Casing: A 10-inch diameter, $\frac{1}{2}$ " thick, steel pipe will be used for the surface protective casing. The steel casing will be penetrate 3 ft into the ground and extend 2 ft above ground surface.
- M. Well Cover: A lockable metal well cover will be provided for the protective casing (MAASS 10LCS custom made or approved equal). Each well cover shall be supplied with a neoprene gasket.
- N. Cement: Type II Portland cement will be used for applications requiring cement.

7. EQUIPMENT

- A. Drilling of the dewatering wells shall be accomplished by use of a suitable well drilling rig. The drilling rig shall have the capabilities of successfully drilling and completing a 6-inch well and a 13-1/2 inch or larger borehole to a depth of at least 60 ft. The Contractor shall have the capability of installing the required PVC casing string, sand pack, bentonite seal, cement/bentonite grout, pump and pump column, and pitless adapter. The Contractor will be required to have the equipment necessary to install the required well surface completion, not including the pipeline to the treatment plant.

8. WELL CONSTRUCTION

- 2
- A. General: The dewatering well shall be completed approximately as described in the following discussion. Site-specific geologic conditions may require changes to well construction plans. Modifications to construction specifications must be approved in advance by the Engineer.
- B. Borehole: A minimum 13-1/2 inch borehole will be drilled to penetrate approximately 6 ft into the Denver Formation underlying unconsolidated alluvium. Conventional rotary drilling, if used, will use water as drilling fluid. Bio-degradable additives, such as Revert, may be used if necessary and approved by the Engineer. Sufficient penetration into the Denver Formation will be specified by the Engineer if local conditions differ from anticipated.
- C. Well String: Install well string consisting of:
- 1) Tailpipe at Bottom: 6 ft long, 6-inch diameter, Schedule 40 PVC with bottom cap or plug.
 - 2) Well Screen:
 - a) 80 slot (0.080 inch) 6-inch diameter continuous PVC wire screen
 - b) Length of well screen will depend upon the elevation of water table in the alluvium. Well screen should extend from 1 ft below the contact between alluvium and Denver Formation to from 0 to 2 ft above water table encountered during drilling operations.
 - 3) Production Casing:
 - a) Blank Schedule 40 PVC, 6-inch diameter
 - b) Extend from well screen to pitless adapter
 - 4) Pitless Adapter: 6-inch diameter with 1-inch diameter discharge at DW-16 and with 1½-inch diameter at DW-17 located at 5 ft below finished grade. The pitless adapter shall be installed by trenching after the well casing has been installed. The area excavated shall be backfilled and

compacted after installation of the pitless adapter.

- 5) Discharge Pipe: Each well will have an individual pipe to the valve pit at DW-15.
 - 6) Centralizers: Centralizers will be clamped to well string on tailpipe, above the screen and on production casing at a maximum spacing of 20 ft on the PVC blank casing.
- D. Sand Pack: Fill annulus between the well string and borehole wall with washed silica sand from total depth of borehole to 3 ft above well screen. Sand pack will be tremied into place. Gradation of sand pack will be dependent upon geologic conditions encountered and as directed by the Engineer. Precautions will be taken during sand pack installation to prevent excessive compaction. Additional sand pack will be added as required to maintain the sand pack approximately 3 ft above the top of the well screen and assure the bentonite seal does not migrate deeply into the sand pack.
- E. Annular Seal:
- 1) A 2-ft thick hydrated granular bentonite tremied on top of sand pack.
 - 2) A cement/bentonite grout to extend from the bentonite seal to 1 ft below pitless adapter; grout will consist of 20 parts cement to 1 part bentonite with maximum of 6.5 gallons of water per sack of cement. The grout will be mixed to the satisfaction of the Engineer.
 - 3) Well construction operations will be conducted continuously from the beginning of sand pack placement until the cement/bentonite slurry has been placed as stated above. Additional cement/bentonite slurry will be added as necessary to maintain the slurry level at the level shown on the drawings.
- F. Production String:
- 1) Pump:
 - a) Grundfos stainless steel submersible pump equipped with pump shroud.

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- b) Install pump intake 1 ft below top of tailpipe.
- 2) Pump Column: Schedule 80 PVC with threaded PVC couplings extended to pitless adapter.
 - 3) Holddown Pipe: Schedule 80 PVC with top cap extending from pitless adapter to within 6 inches below top of protective casing.
 - 4) Power Cable: Taped to pump column using black vinyl electrician tape.
 - 5) Water Level Sensors: See Instrumentation specification.
 - 6) Check Valves: Two required in each well, including one integral to the pump.
 - 7) Safety Cable: 3/16-inch 316 stainless steel safety cable, attached to pump and 1/2-inch steel eye welded to protective steel casing.
- G. Surface Completion:
- 1) Protective Casing: 10-inch steel pipe with 12-1/4 inch flanged bottom and vented lockable metal well cap, extending from 3 ft in ground to 2 ft above ground cement annular seal. Flanged casing is required to prevent ground cement annular seal from reaching pitless adapter. The casing shall be painted red.
 - 2) Well Pad: 48-inch square, 6-inch thick wire-reinforced concrete pad, centered on well and sloped away from well for drainage.
 - 3) Protective Barricade: Four concrete filled 4-inch diameter steel pipes, 8 ft long, buried 5 ft into ground in 8-inch diameter concrete-filled boreholes, painted yellow, located 12 inches from corners of well pad.
- H. Well Drill Cuttings: Well cuttings produced during drilling operations from the saturated zone will be considered potentially contaminated. These cuttings will be secured in 55-gallon steel drums provided by the Engineer. The Engineer will arrange for the ultimate disposal of well drill cuttings.

- I. Surveying: The top of the new dewatering well will be surveyed by the Engineer.

9. WELL DEVELOPMENT

- A. The well shall be developed following completion of construction activities. Well development shall be conducted by alternately surging and bailing the well as directed by the Engineer, and shall include surging of all screened sections of the aquifer. Surging shall be performed by use of a surge block or bailer of minimum 5-inch outside diameter. Wells shall be developed for a minimum of two hours, or until discharge water during surging of all screened well sections are essentially free of sand, whichever is more. Water removed from a well during development shall be visually monitored for sand content and turbidity. A minimum of 15 gallons per foot of saturated alluvial thickness shall be bailed from each well during well development. The total volume of water removed during well development shall be recorded. Water generated during well development activities shall be collected in suitable drums or tanks provided by the Engineer and disposed of by the Engineer. The Engineer will arrange for disposal of well development water.

10. CLEANUP

- A. At completion and before acceptance of this work, all equipment, surplus materials and rubbish shall be removed, leaving the site in a neat, presentable condition acceptable to the Engineer.

11. QUALITY CONTROL

- A. General: The Contractor shall maintain records as required by the Engineer to assure that well construction is being conducted within contract limits. The results of drilling construction and development activities shall be documented to assure they meet specifications. The Contractor shall maintain records of observations, measurements and tests performed. These records shall be furnished to the Engineer no later than 24 hours after the tests, measurements, and/or observations are made.
- B. Well Construction Log: The Contractor shall maintain a well construction log of daily activities. The well construction log shall identify subsurface geologic occurrences encountered during well construction. The

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depth to the groundwater table and the Denver Formation shall be identified.

12. DISINFECTION

- A. After the well has been properly developed, it shall be chlorinated. To accomplish this, the Contractor shall add calcium hypochlorite (65% available chlorine) or sodium hypochlorine solution to the well water such that the solution strength does not exceed 200 ppm. Chlorination shall be accomplished through the entire depth of the well and the well shall stand for 8 hours minimum before the chlorinated water is pumped to waste.
- B. The Contractor shall take all necessary precautions to prevent contamination of water from outside sources.

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SPECIFICATION 34-0272

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

ALLUVIAL MONITORING WELL

CLIENT: SHELL OIL COMPANY

PROJECT: NORTHWEST BOUNDARY SYSTEM IRA

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION 34-0272
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA
ALLUVIAL MONITORING WELLS

1. SCOPE

- A. One 4-inch diameter alluvial monitoring well will be constructed along the slurry trench at the Northwest Boundary. The well is expected to be about 40 ft in depth. The Contractor will furnish equipment, labor and materials, and perform operations as required to construct the well. Design details are presented on Drawing 34-002.

2. RELATED WORK

- A. The following related work is covered in other specifications:
- 1) Cast-in-place Concrete (Specification 34-0301)
 - 2) Site Preparation and Grading (Specification 34-0202)
 - 3) Excavation and Backfilling (Specification 34-0203)

3. REFERENCE STANDARDS

- A. Organizations whose standards are referenced herein include the following:
- 1) ASTM - American Society for Testing and Materials
 - 2) API - American Petroleum Institute

4. CONTRACTOR QUALIFICATIONS

- A. The Contractor shall submit evidence, including drilling experience in the Denver area and a list of available drilling and support equipment to the Engineer, to show that he is competent to construct wells of the design provided by the Engineer. This evidence should ensure that the Contractor will have sufficient competent,

experienced personnel to construct the monitoring wells. A qualified well driller, having a current State of Colorado drilling certification and approved by the Engineer, will supervise the construction including well drilling, casing installation, slurry preparation and installation, and well completion activities.

5. ALLUVIAL MONITORING WELL DESCRIPTION

- A. The monitoring wells will consist of a nominal 10-inch auger borehole (6½-inch hollow-stem) to total depth. The well will be completed with 4-inch Schedule 40 PVC slotted and blank casing with a sand pack, bentonite seal, and cement/bentonite grout seal. A vented lockable well cap, 8-inch steel protective surface casing and concrete well pad will complete the surface installation.

6. MATERIALS

- A. Blank Casing: The well casing will be 4-inch Schedule 40 flush-threaded PVC pipe with a vented, Schedule 40 PVC cap.
- B. Well Screen: The well will be completed with Schedule 40 PVC 20-slot (0.020 inch) commercially manufactured and slotted casing having a solid, one-piece bottom cap or plug.
- C. Sand Pack: The sand pack will consist of washed silica sand. It is anticipated that 10/20 sand will be used. Sand pack characteristics may be changed by the Engineer dependent upon subsurface geologic conditions.
- D. Bentonite: Bentonite used shall be sodium cation base montmorillonite premium grade Wyoming-type bentonite, which conforms to the most recent applicable API specifications. The Contractor shall furnish to the Engineer a certificate of compliance. Bentonite will be protected from moisture during transit and storage.
- E. Water: A source of water for use during drilling operations will be identified by the Engineer.
- F. Protective Casing: An 8-inch Schedule 40 steel pipe will be used for the surface protective casing. The steel casing shall be 5 ft long, and be buried 3 ft in the ground. The steel casing shall have a metal, lockable cap (MAASS 8LCR or equal).

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- G. Cement: Type II Portland cement will be used for applications requiring cement.

7. EQUIPMENT

- A. Drilling of the alluvial monitoring well shall be accomplished by use of a suitable hollow-stem auger well drilling rig. The drilling rig shall have the capabilities of successfully auger drilling and completing a 4-inch well in a nominal 10-inch auger borehole to a depth at least 60 ft. The Contractor shall have the capability of installing the required PVC casing string, sand pack, bentonite seal, and cement/bentonite grout. The Contractor will be required to have the equipment necessary to install the required surface completion.

8. WELL CONSTRUCTION

- A. General: One alluvial observation well will be completed approximately as discussed in the following sections. Site-specific geologic conditions may require changes to well construction plans. Modifications to construction specifications must be approved in advance by the Engineer.
- B. Borehole: A nominal 10-inch auger borehole will be drilled to penetrate approximately 1 ft into the Denver Formation. Sufficient depth into the Denver Formation will be specified by the Engineer in the field.
- C. Well String: A well string consisting of, from bottom to top, 4-inch, 20-slot (0.020-inch) Schedule 40 PVC slotted casing with bottom cap or plug and blank casing will be installed. The length of the well screen will be dependent upon the elevation of the water table encountered during drilling operations. The well screen will extend from 0 to 5 ft above the water table encountered during drilling operations. From the top of the well screen and extending two feet above the ground level will be the production casing, consisting of 4-inch diameter Schedule 40 flush-threaded PVC casing.
- D. Sand Pack: The sand pack will extend to 3 ft above the top of the slotted casing. Precautions will be taken during sand pack installation to prevent excessive compaction. Additional sand pack will be added as required to maintain the sand pack approximately 3 ft above the top of the slotted casing and assure the

bentonite seal does not migrate deeply into the sand pack.

- E. Annular Seal: A 2-ft hydrated bentonite seal will be placed on top of the sand pack. A cement/bentonite grout will be placed from the bentonite seal to 3 ft below finished grade. Well construction operations will be conducted continuously from the beginning of sand pack placement until the cement/bentonite grout reaches desired elevation. Additional cement/bentonite grout will be added as necessary to maintain the grout level at the desired level. The grout shall consist of 20 parts cement to 1 part bentonite with a maximum of 6.5 gallons of water per sack of cement. The sand pack, bentonite seal and cement/bentonite grout shall be tremied into place.

F. Surface Construction:

- 1) Protective Casing: 8-inch steel pipe with a lockable cover and vented well cap, extending from 3 ft in ground to 2 ft above ground and painted yellow shall be installed.
- 2) Well Pad: 48-inch square, 6-inch thick concrete pad centered on well and sloped away from the well for drainage, extending into the borehole annulus to the top of the cement/bentonite grout.

- G. Well Drill Cuttings: Well cuttings produced during drilling operations from the saturated zone will be considered potentially contaminated. These cuttings will be secured in 55-gallon steel drums. The Engineer will arrange for the ultimate disposal of well drill cuttings.

- H. Surveying: The top of the alluvial monitoring wells will be surveyed by the Engineer.

9. WELL DEVELOPMENT

- A. The wells shall be developed following completion of construction activities. Well development shall be conducted by alternately surging and bailing each well as directed by the Engineer, and shall include surging of all screened sections of the aquifer. Surging shall be performed by use of a surge block or bailer of minimum 3-inch outside diameter. Wells shall be developed for a minimum of two hours, or until discharge water during surging of all screened well sections is essentially free

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of sand, whichever is more. Water removed from a well during development shall be visually monitored for sand content and turbidity. A minimum of 15 gallons per foot of saturated alluvial thickness shall be bailed from each well during well development. The total volume of water removed during well development shall be recorded. Water generated during well development activities shall be collected in suitable drums or tanks provided by the Engineer and disposed of by the Engineer. The Engineer will arrange for the disposal of well development water.

10. CLEANUP

- A. At completion and before acceptance of this work, all equipment, surplus materials and rubbish shall be removed, leaving the site in a neat, presentable condition acceptable to the Engineer.

11. QUALITY CONTROL

- A. General: The Contractor shall maintain records as required by the Engineer to assure that well construction is being conducted within contract limits. The results of drilling construction and development activities shall be documented to assure they meet specifications. The Contractor shall maintain records of observations, measurements and tests performed. These records shall be furnished to the Engineer no later than 24 hours after the tests, measurements, and/or observations are made.
- B. Well Construction Log: The Contractor shall maintain a well construction log of daily activities. The well construction log shall identify subsurface geologic occurrences encountered during well construction. The depth to the groundwater table and the Denver Formation shall be identified.

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SPECIFICATION 34-0301

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

CAST-IN-PLACE CONCRETE

CLIENT: SHELL OIL COMPANY

PROJECT: NORTHWEST BOUNDARY SYSTEM

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION 34-0301
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA
CAST-IN-PLACE CONCRETE

1. SCOPE

- A. The cast-in-place concrete requirements consist only of the various non-reinforced thrust blocks and supports for piping installed underground, and the concrete caps and aprons at well heads, and the concrete used in constructing the steel protective posts as shown on the design drawings.
- B. This specification applies only for the above said type of work. In the event that other more extensive cast-in-place concrete becomes necessary, other appropriate specifications would be issued.

2. RELATED WORK

- A. The following related work is covered in other specifications:
 - 1) Excavating and Backfilling (Specification 34-0203).
 - 2) Piping and Instrumentation (Specification 35-1501).

3. REFERENCE STANDARD

- A. Organizations whose standards are referenced herein include the following:
 - 1) ACI - American Concrete Institute
 - 2) ASTM - American Society for Testing and Materials
- B. Any references to the above standards shall be the edition in effect as of the date of this specification unless otherwise stated.

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4. GENERAL

- A. Shop Drawings: None are required and none will be furnished. Cast-in-place concrete shall be located and sized as required by the design drawings.
- B. Earth Compaction. The earth upon which each of the concrete thrust blocks will bear shall be undisturbed soil.

5. MATERIALS

- A. Concrete: 3,000 psi or commercial dry mix for pouring small quantities.
- B. Portland Cement: ASTM C150, Type II.
- C. Sand: ASTM C144, washed natural sand, free from impurities.
- D. Aggregate: Washed natural aggregate maximum 1/2" size, free from impurities.
- E. Water: Free of deleterious amount of acids, alkalis, and organic materials.
- F. Bars: All reinforcing bars shall be deformed bars conforming to ASTM A615, Grade 60.
- G. Welded Wire Fabric: All fabric shall conform to ASTM A185.

6. FINISH

- A. Trowel finish the concrete aprons at well heads.

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SPECIFICATION 35-1501

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

PIPING AND INSTRUMENTATION

CLIENT: SHELL OIL COMPANY

PROJECT: NORTHWEST BOUNDARY SYSTEM IRA

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION 35-1501
NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS IRA
PIPING AND INSTRUMENTATION

1. SCOPE

- A. This specification and applicable design drawings cover the furnishing, installing, and testing of underground piping and instrumentation to carry raw groundwater to the existing Northwest Boundary groundwater headed at DW-15 valve pit.
- B. The work includes:
- 1) Connecting to an existing 2" galvanized pipeline leading to the Northwest Boundary System Treatment Plant. The existing line is located in the well valve pit adjacent to Dewatering Well #15.
 - 2) Install the underground piping and associated valves from two new dewatering wells (DW-16 & DW-17).
 - 3) Piping inside the well valve pit.
 - 4) Flowmeter in each of the discharge lines.

2. RELATED WORK

- A. Related work is covered in other specifications:
- 1) Excavating and Backfilling (Specification 34-0203)
 - 2) Cast-in-place Concrete (Specification 34-0301)

3. REFERENCE STANDARDS

- A. The piping components and instruments shall be designed, manufactured, and tested in accordance with applicable standards and references:
- 1) ASTM - American Society for Testing and Materials

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- 2) ANSI - American National Standards Institute
- 3) ISA - Instrument Society of America
- 4) Text, Plastic Piping Systems, by David A. Chasis
- 5) National Sanitation Foundation
- 6) AWWA - American Water Works Association

4. GENERAL REQUIREMENTS

A. Codes, Permits and Fees, Tests, and Certificates:

- 1) All work performed under this specification shall meet the requirements of the codes, rules, and/or regulations of the State of Colorado and the Federal Government.
- 2) The U.S. Army shall obtain and pay for all permits and certificates of inspection required for this work by governing authorities.
- 3) Notification shall be given to the U.S. Army of all tests performed during progress of the work and prior to completion, so an Army representative may witness the tests.

B. Coordination and Interferences:

- 1) MK-ES shall be responsible to coordinate the work under this specification with work performed in the same areas by other trades such as the site work, excavating, grading, and trench and well construction.
- 2) MK-ES shall also request that the location of any underground utilities be identified by an Army representative.

5. MATERIAL REQUIREMENTS

A. General:

- 1) Refer to Items 1.B.1) and 2), above. The underground pipeline and fittings shall be PVC manufactured from a compound that meets the requirements of Type 1, Grade 1, polyvinyl chloride as outlined in ASTM D1784. A Type 1, Grade 1

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compound is characterized as having the highest requirements for mechanical properties and chemical resistance.

- 2) The compound from which PVC pipe is produced shall have a design stress rating of 2,000 psi at 73°F, listed by The Plastic Pipe Institute.
 - 3) Materials from which PVC pipe and fittings are manufactured shall have been tested and approved for conveying potable water, by The National Sanitation Foundation.
 - 4) PVC pipe shall conform to the requirements of ASTM D1785. Fittings shall conform to the requirements of ASTM D2467 for Schedule 80 socket type and ASTM D2464 for Schedule 80 threaded type. All PVC socket and threaded connections shall be joined and installed using the manufacturer's recommended procedure.
 - 5) The PVC pipe and fittings shall be supplied by an approved manufacturer.
- B. The valves shown on Drawings C-001, C-002, & P-001 shall be supplied by the manufacturers indicated, or approved equal.
- C. All pipe fittings and nipples located in the well valve pit shall be threaded galvanized steel Class 150, or Class 3000 forged steel, as indicated on MK-ES Drawing.
- D. The flowmeters for the 2 dewatering wells shall be Hersey 1" diameter Model MVR 50 turbine meters.

6. INSTALLATION AND TESTING OF PVC PIPE

- A. Instruction: Installation workers shall be instructed in the proper handling and joining techniques. Piping shall not be thrown, whipped, or dropped during handling.
- B. Storage: In outside storage, the pipe and fittings shall be covered with light tarpaulin to prevent excessive heat build-up. Loose pipe stacks shall not exceed 3 feet in height.
- C. Excavation, Trenching and Backfill shall be according to the requirements of Specification 34-0203 except as otherwise specified herein or on the drawings.

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Generally, installations of PVC pipe shall be in open trenches. The trench width below top of pipe barrel shall be the minimum required to provide working space for pipe jointing, bedding, and inspection.

- D. Bedding: PVC pipe shall be bedded on material free from rock particles greater than 1/2-inch diameter in such a way as to support the full barrel length. If natural bedding materials do not meet these requirements or will not provide adequate pipe support, overexcavate and place a minimum of 4 inches of tamped sand to provide pipe support.

E. Backfilling:

- 1) After the pipe is bedded and successfully initially tested as described under Section 6.F, the pipe shall be covered with 6 to 8 inches of soil free of rocks, debris, or particles larger than one-half inch. This initial backfill layer shall be tamped to restrain the pipe during high-pressure testing, and to act as a cushion for final backfill.
- 2) After successfully passing the high-pressure test, the initial soil cover shall be compacted on both sides of the pipe, with special care at the pipe haunches. Material placed at pipe joints shall not be compacted. Final backfill shall not contain any large sharp rocks in the first 18 inches that could penetrate the initial cushioning layer. Afterwards, the remaining backfilling will be accomplished according to Specification 24-0203.
- 3) Install caution tape as indicated on the drawings.

F. Testing:

- 1) After the pipe is bedded, an initial hydrostatic test shall be conducted at 10% of maximum test pressure, not to exceed 50 psi, to ascertain any initial leakage. Solvent-cemented joints shall have dried a specified period of time dependent on the surface temperature. After a successful initial test, sufficient backfill shall be placed as mentioned above to prevent pipe movement during subsequent high-pressure testing.

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- 2) The high test pressure shall be between 1.2 and 1.5 times the maximum operating pressure or the design pressure rating, whichever is lower.
- 3) Maximum operating pressure shall be 60 psig.
- 4) The high-pressure test shall be conducted for a period of not less than 2 hours. To successfully pass the high-pressure test, the volume of water required to maintain the test pressure shall not exceed the amount calculated by the equation:

$$L = \frac{ND P^{\frac{1}{2}}}{7400}$$

where L = makeup water (gal./hr)
N = number of joints in the tested line
D = nominal pipe diameter (in.)
P = average test pressure (psi)

- 5) When testing sections of line having more than one pipe size, the allowable leakage shall be computed by applying the above equation to each section of pipe having a different diameter, then summing the allowable leakages for each pipe section.
- 6) Test records shall be delivered to an Army representation by MK-ES.
- 7) In the event that low temperatures make testing with water impractical, an equivalent air test will be allowed.

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SPECIFICATION 37-1601

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

ELECTRICAL WORK

CLIENT: SHELL OIL COMPANY

PROJECT: NORTH BOUNDARY SYSTEM IMPROVEMENTS IRA

LOCATION: ROCKY MOUNTAIN ARSENAL, COMMERCE CITY, CO

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SPECIFICATION 37-1601
NORTH BOUNDARY SYSTEM IMPROVEMENTS
RECHARGE TRENCH PROJECT IRA
ELECTRICAL WORK

1. SCOPE

- A. This specification and applicable drawings cover the furnishing and installing of electrical work as required by the drawings and as specified herein.

2. REFERENCE STANDARDS

- A. All equipment, materials, construction and installation shall be in accordance with the following applicable codes and standards:
- 1) ANSI - American National Standards Institute
 - 2) NEMA - National Electrical Manufacturers Association
 - 3) NFPA/ - National Fire Protection Association/
NEC National Electrical Code
 - 4) Applicable State of Colorado Electrical, Building, Energy, Fire, and Safety Codes
 - 5) Local codes

3. RELATED WORK

- A. Several items of work are specified in other specifications and are not included in the work covered by this specification.
- 1) Excavating and Backfilling (Specification 34-0203)
 - 2) Manholes (Specification 35-1511)
 - 3) Piping and Instrumentation (Specification 35-1501)

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4. GENERAL REQUIREMENTS

- A. In the event of any discrepancy between one drawing and another or between the drawings and this specification, the Contractor shall bring such discrepancies to the attention of the Engineer for a ruling.
- B. It shall be the Contractor's responsibility to assure that all requirements of inspection authorities are complied with.
- C. Names of approved manufacturers are listed in this specification to establish a standard of quality. Products of other manufacturers may be used with the approval of the Engineer.

5. REQUIRED ITEMS OF WORK

- A. The work involved shall be in accordance with the following:
 - 1) The drawings for construction and their references.
 - 2) The contents and references of this specification.
 - 3) The installation instructions of the manufacturers of equipment or materials supplied to the Contractor for installation.
- B. All electrical systems, both above grade and below grade, shall be completed as outlined on the drawings and in this specification, and be ready for use.
- C. Labor and materials which are necessary for the completion and satisfactory operation of the electrical installation shall be furnished.

6. WIRE AND CABLE METHODS

- A. General: As required by the drawings, all power and control wiring shall be furnished and installed, unless otherwise specified, and shall meet NEC standards for wire, cable and workmanship.
- B. 600-V Conductors: All single conductor wiring for power installed in conduit for operating at 600 V or below shall be UL approved stranded soft annealed copper, type XHHW or THHN.

1. CONDUIT AND CONDUIT FITTINGS

A. General: Conduit sizes, type and length shall be furnished and installed as required by the drawings and meet the latest edition of the NEC.

B. Materials:

1) Conduit:

- a) Rigid Galvanized Steel Conduit shall conform to ANSI C80.1 and be standard weight mild rigid steel, hot-dipped galvanized with inside and outside finished with a minimum zinc coating. Couplings, elbows and fittings shall meet these same requirements. All shall be of the threaded type.
- b) Flexible Conduit shall be equal to or better than integral grounding conductor, per ANSI C90.1, Anaconda Sealtite type EA or equal.
- c) PVC-coated Steel Conduit shall conform to ASTM A513 and be standard weight, mild rigid steel, hot-dipped galvanized prior to application of coating. Coating shall be a minimum of 0.004" of polyvinyl chloride bonded to the exterior of the conduit. Couplings, elbows, conduit fittings and fittings shall be PVC coated and meet the same requirements as the coated conduit. For the item mentioned above, such as couplings, etc., shall have a flexible PVC sleeve which extends from each end of the coupling and which will overlap the PVC coating on the conduit when the coupling has been installed on the conduit.

2) Boxes and Fittings:

- a) Exposed Work: All conduit fittings, junction and device boxes shall be cast Type I or II with threaded hubs, steel covers and gaskets for use with RGS.
- b) For weatherproof locations, proper sealing gaskets in addition to self-closing hinged lids for receptacle covers shall be provided.

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- C. Installation:

- a) Above grade conduit shall be rigid galvanized steel conduit.
- b) Field bends and offsets shall be uniform and symmetrical, without conduit flattening or finish scarring. Field bends shall be made with standard tools and equipment manufactured specifically for conduit bending. Minimum bend radii shall be as required by the NEC, but in no case less than six times conduit diameter.
- c) All conduit ends shall be cut square, properly threaded and reamed. All connections and joints shall be made tight and weatherproof, engaging not less than five threads, and coated with approved thread compound, such as "Kopr-Shield" compound manufactured by Thomas and Betts. All steel conduit joints shall be weatherproof, using suitable metal oxide for joint makeup.
- d) Pull fittings or boxes shall be installed wherever necessary on conduit systems to facilitate pulling wire and cables, and shall be in accessible locations.
- e) Open ends of conduit shall be carefully plugged or capped during construction to prevent the entrance of foreign materials or moisture into the conduit. Before pulling wire or cable into the conduit system, a swab shall be drawn through the entire length of the conduit to remove any moisture, metal cuttings or other foreign material.
- f) Outside above grade conduit runs that are extended below grade shall be provided with drain-seal fittings in a vertical drop directly above grade.

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- g) Conduit connections to flowmeters shall be liquid-tight flexible steel conduit with suitable fittings.
 - h) In wet areas indoors and areas subject to washdown, the entire wiring system, boxes, conduit, and fittings must be mounted so that 1/4 inch minimum space exists between system and supporting surface.
 - i) At all entrances to panelboards, pull boxes or outlet boxes (without threaded hubs or bases), conduit runs shall be secured in place by a galvanized locknut with an O-ring seal outside the box and a locknut and bushing on the inside. Bushings shall be of the insulating type. NEMA 1 panelboards, pull boxes, etc., shall be secured in place by a galvanized locknut outside the box and a locknut and bushing inside. Bushings shall be of the insulating type.
 - j) Exposed conduit shall be rigidly maintained and fastened to structural steel by means of an approved clamp or device made for this purpose. On masonry structures, conduits shall be fastened with one-hole conduit clamps and backstrips with flush anchors. The type of conduit support will depend on the type of construction, and/or details as indicated on drawings. Pull boxes shall be rigidly supported with structural steel supports. It shall remain in the Contractor's scope of work to furnish and install any and all support structures when none are specifically furnished.
 - k) All steel bolts, nut, washers and screws shall be galvanized or cadmium plated.
 - l) Conduit bodies Type "LE," "LR," "LT," etc., shall not be used as splice boxes.
 - m) Conductor supports shall be in accordance with the NEC and the method of support shall be approved in writing by the Engineer.
- 2) Conduit in Contact with Earth:

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- a) Conduit in direct contact with earth shall be PVC coated steel conduit.
- b) Conduits shall be installed on minimum of four-inch sand bedding at the bottom of the trench after the trench has been smoothed and tamped. Refer to the construction drawings for details.
- c) The installation of PVC-coated conduit shall follow the installation instructions recommended by the manufacturer. Herein are extra steps to follow:
 - Care must be taken to minimize damage to the PVC coating during cutting, threading, bending and assembly of components.
 - Exposed metal due to damage of the PVC coating must be touched up with compound recommended by PVC-coated conduit manufacturer.
 - To field cut, use a clamp-type vise, tighten to hold conduit securely. Cut conduit with a hacksaw or power saw.
 - All conduits shall be reamed after cutting. Reamer shall be designed for use on PVC-coated conduit.
 - Use only tools approved or recommended for use on PVC-coated conduit.
- d) Conduit bending radii shall be as large as possible and shall be not less than eight times nominal conduit diameter, and free from flats, kinks or damage.
- e) Conduit installation shall follow excavating as closely as possible. Conduit shall be installed in dry trenches maintained free of accumulated water.
- f) Conduit runs shall be kept closed at all times using pipe caps or plugs.

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- g) After conduits are in place, backfill and compact fill to a depth above conduits as specified in drawings and applicable specifications. Install a continuous warning strip of red plastic in the excavation and continue backfill per drawings and specifications.
- h) Conduits in the same trench shall have a minimum horizontal and vertical separation of three inches.

8. GROUNDING SYSTEM

- A. All non-current carrying metal parts of electrical equipment and installations shall be connected to the grounding electrode system as required by the NEC. These will include, but not necessarily be limited to, electrical and instrument equipment enclosure, terminal boxes, steel supporting structures, etc.
- B. Equipment remote from the existing main ground grid may be grounded by separate grounding electrodes and conductors. The resistance to ground of the completed system shall be less than 5 ohms.
- C. Copperweld ground rods shall be 3/4 inch x 10 feet. Top of ground rods shall be a minimum of two feet below grade. Additional section of rods shall be driven as required to obtain the required system resistance.

9. AS-BUILTS

- A. One (1) complete set of drawings issued for this contract shall be maintained exclusively for record purposes by the Contractor and all changes and modifications shall be shown and noted thereon in red color. Supplemental drawings or sketches may be added. Dimensions, clearances, sizes and significant references shall be added.
- B. Drawings shall be kept neat and clean, and shall be available at all times for reference. All sketches, notes and data shall be sufficiently clear to permit photo reproductions when needed.
- C. As-built drawings must be submitted to MK-ES at the completion of the work.

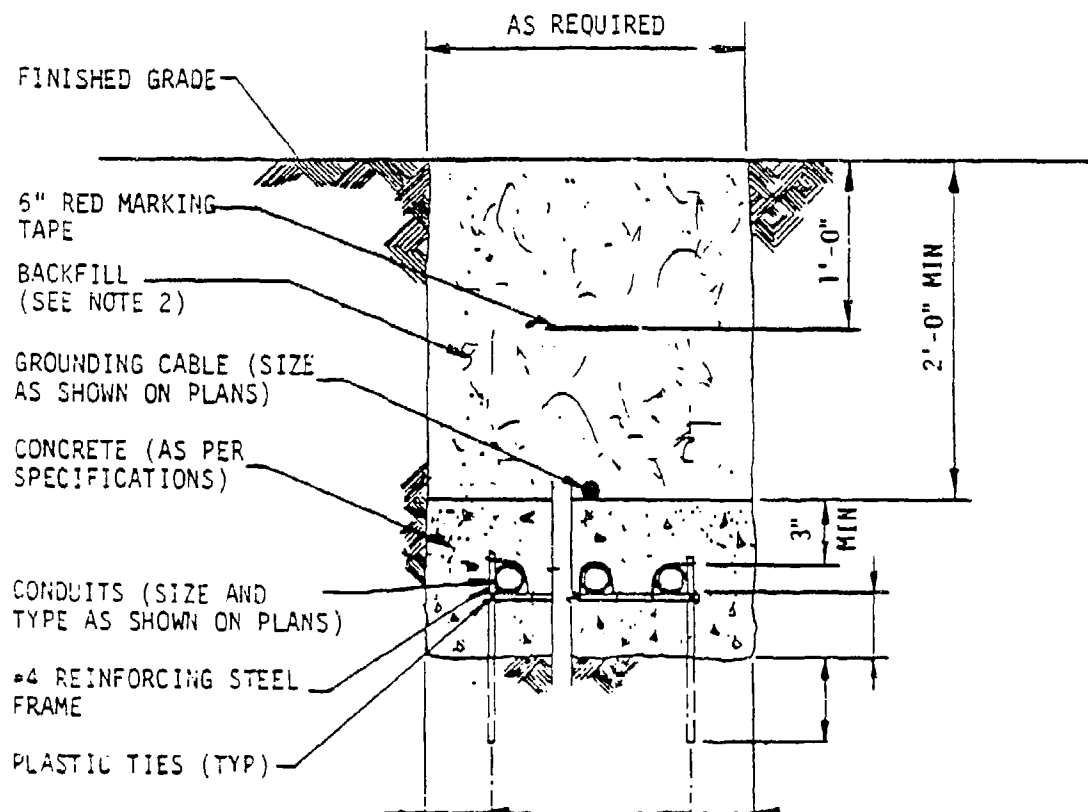
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APPENDIX A


STANDARD ELECTRICAL DETAILS

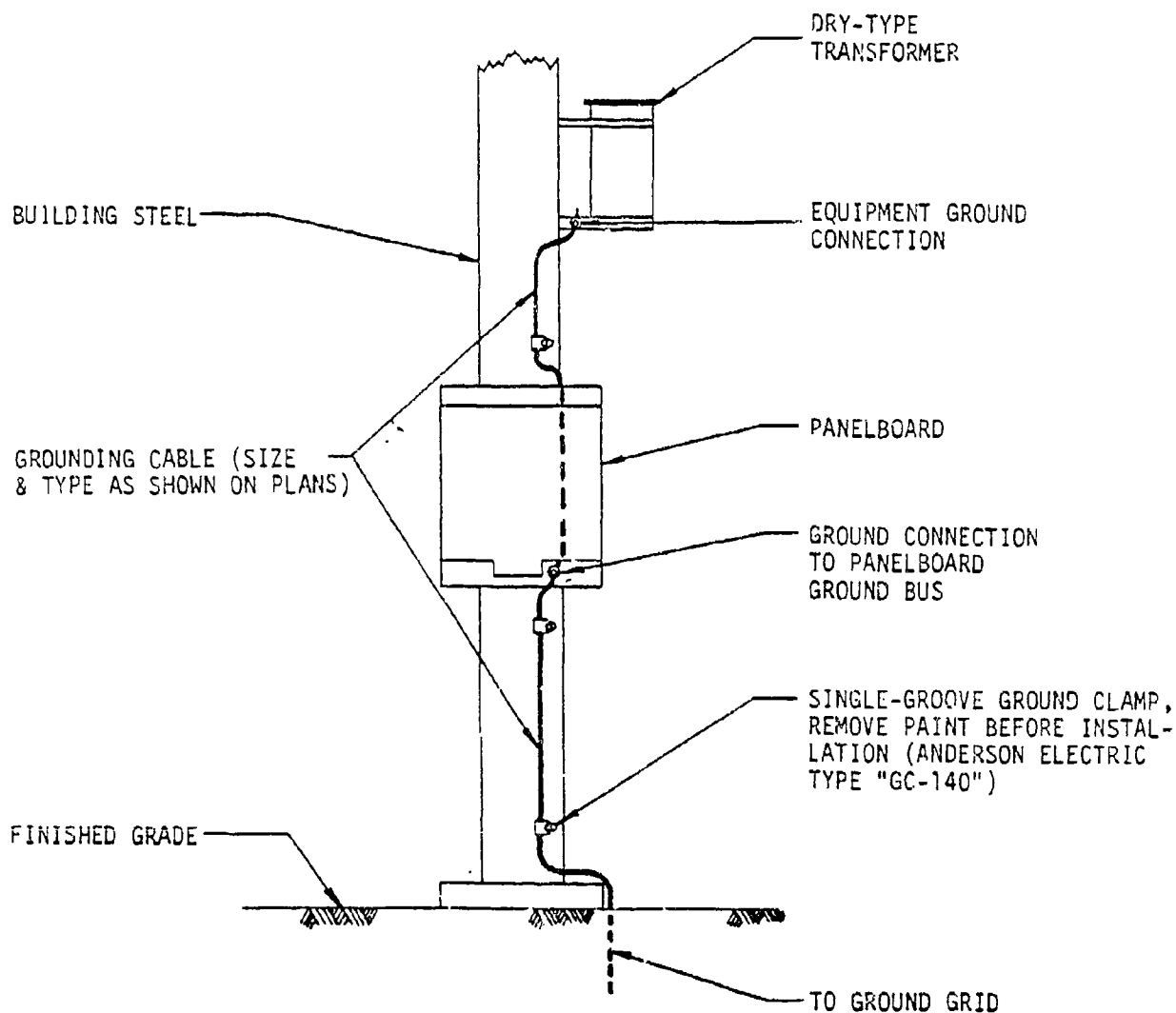
<u>SHEET</u>	<u>TITLE</u>
ESD3-17	DUCT BANK CONCRETE ENCASED
ESD7-5	GROUND CONNECTION TO PANELBOARD AND DRY-TYPE TRANSFORMER (COLUMN MOUNTED)
ESD7-10	GROUND CONNECTION TO EQUIPMENT MOUNTING STEEL WITH RISER (BOLTED)
ESD7-37	GROUND CONNECTION CABLE TO GROUND ROD (END)
ESD7-40	GROUND CONNECTION CABLE TO CABLE (TEE)



NOTES:

1. MINIMUM SEPARATION BETWEEN CONDUITS SHALL BE 3 INCHES.
2. USE ENGINEER APPROVED MATERIALS OBTAINED FROM: STOCKPILES OF EXCAVATED MATERIAL, BORROW AREAS, OR OFF-SITE LOCATIONS. IN AREAS WHERE THE TYPE OF BACKFILL IS NOT DESIGNATED, NATIVE BACKFILL MAY BE USED WITH THE ENGINEER'S PRIOR APPROVAL. BACKFILL SHALL BE COMPACTED TO 95% IN PLANT AREAS AND 85% IN OTHER AREAS AS PER ASTM D698.

		DRAWN BY RFC	APPROVED BY TRA. RU 04/20/BI	 MORRISON-KNUDSEN COMPANY, INC. DUCT BANK CONCRETE ENCASED (1 HORIZONTAL ROW OF 1" TO 2" CONDUITS) TWO MORRISON-KNUDSEN PLAZA / P.O. BOX 7806 / BOISE, ID 83729
		CHECKED BY KHP	SCALE 	
		CONTRACT NUMBER 5000		
		SHEET NUMBER ESD3-17		
02 GENERAL REVISION	1 K-R			
DATE	REVISION OR ISSUE	NO	BY	



DRAWN BY *KB* APPROVED BY *KB*
 CHECKED BY *KB* 9/26/78
 SCALE

CONTRACT NUMBER

5000

SHEET NUMBER

ESD7-5



MORRISON-KNUDSEN COMPANY, INC.

GROUND CONNECTION
 TO PANELBOARD AND
 DRY-TYPE TRANSFORMER
 (COLUMN MOUNTED)

TWO MORRISON-KNUDSEN PLAZA/P.O. BOX 7808/BOISE, ID 83729

GENERAL REVISION

REVISION OR ISSUE

NO. BY

EQUIPMENT MOUNTING STEEL,
DRILL AS REQUIREDSINGLE-GROOVE GROUND
CLAMP, SPACED 5'-0"
MAX O. C., REMOVE PAINT
BEFORE INSTALLATION
(ANDERSON ELECTRIC
TYPE "GC-140")GROUNDING CABLE (SIZE &
TYPE AS SHOWN ON PLANS)DOUBLE-GROOVE GROUND
CLAMP, REMOVE PAINT BEFORE
INSTALLATION (ANDERSON
ELECTRIC TYPE "GC-143")

9" APPROX

GRAVEL SURFACING
(AS SHOWN ON PLANS)

FINISHED GRADE

TO GROUND GRID

NOTE: GROUND CLAMPS SHALL BE SIZED ACCORDING TO MANUFACTURER'S SPECIFICATIONS
FOR SIZE CABLE USED, AS SHOWN ON PLANS.

DRAWN BY *K.A.A.* APPROVED BY *K.A.A.* 10/14/78
CHECKED BY *K.B.* 1/27/78
SCALE

CONTRACT NUMBER
5000

SHEET NUMBER
ESD7-10

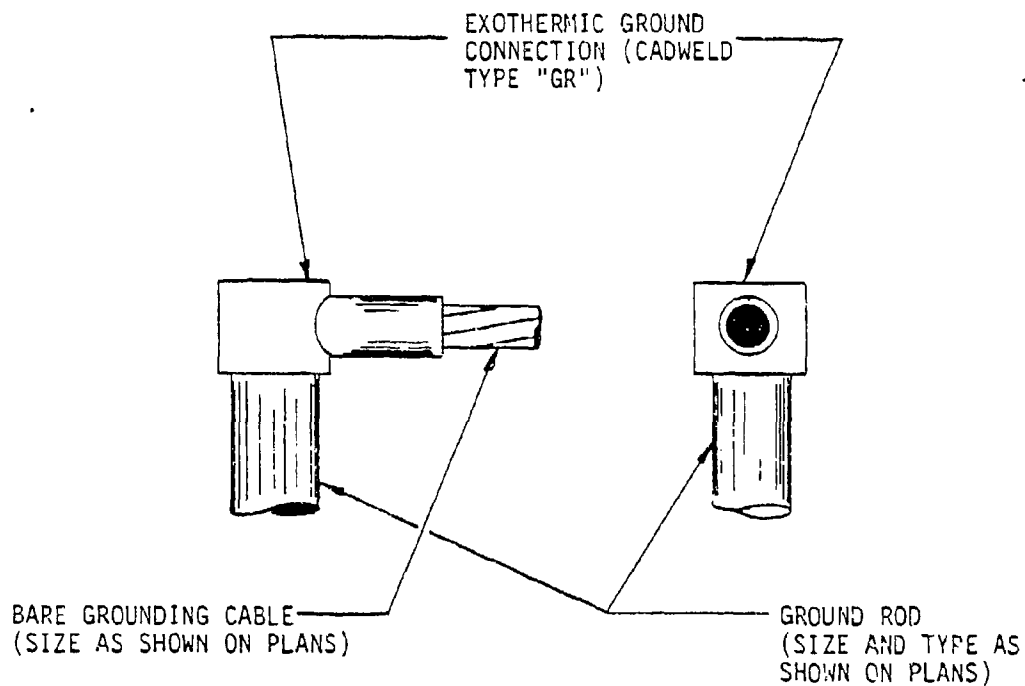


MORRISON-KNUDSEN COMPANY, INC.

GROUND CONNECTION
TO EQUIPMENT MOUNTING
STEEL WITH RISER
(BOLTED)

TWO MORRISON-KNUDSEN PLAZA/P.O. BOX 7808/BOISE, ID. 83729

DATE	REVISION OR ISSUE	NO.	BY
3/23/82	GENERAL REVISION	1	<i>K.A.A.</i>



NOTE: EXOTHERMIC GROUND CONNECTION SHALL BE SIZED ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS FOR SIZE CABLE AND ROD USED, AS SHOWN ON PLANS.

DRAWN BY *SKA* 10/11/75
 CHECKED BY *KB* 10/11/75

SCALE

CONTRACT NUMBER

5000

SHEET NUMBER

ESD7-37

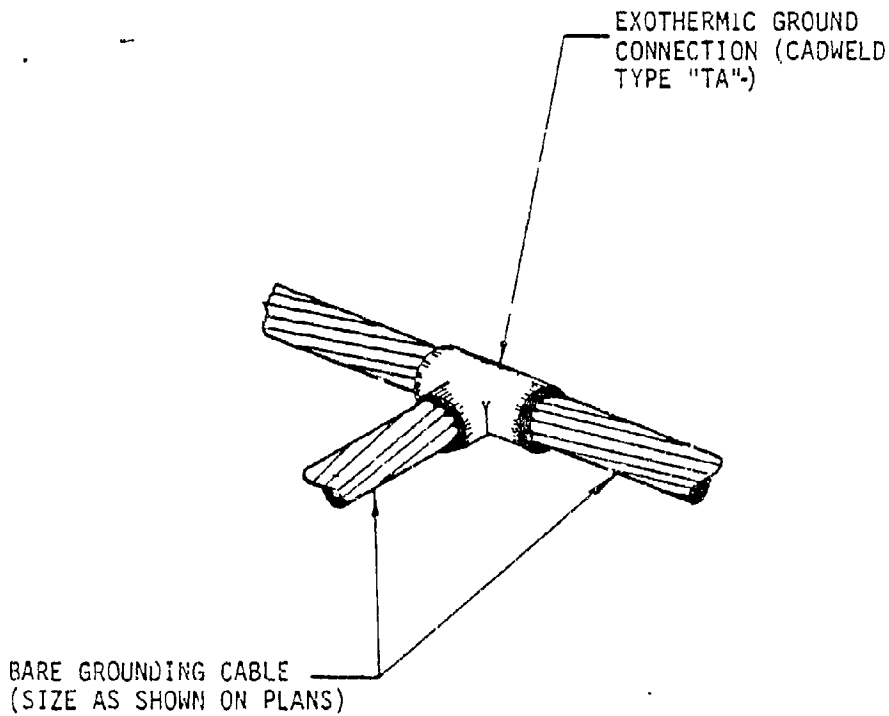


MORRISON-KNUDSEN COMPANY, INC.

GROUND CONNECTION
 CABLE TO GROUND ROD
 (END)

TWO MORRISON-KNUDSEN PLAZA/PO. BOX 7808/BOISE, ID 83729

REVISION OR ISSUE NO. BY



NOTE: EXOTHERMIC GROUND CONNECTIONS SHALL BE SIZED ACCORDING TO THE MANUFACTURER'S SPECIFICATIONS FOR SIZE CABLE USED, AS SHOWN ON PLANS.

DRAWN BY K.B.	APPROVED BY K.N.A. 10/11/78
CHECKED BY KB 10/11/78	SCALE
CONTRACT NUMBER 5000	
SHEET NUMBER ESD7-40	



MORRISON-KNUDSEN COMPANY, INC.

GROUND CONNECTION
CABLE TO CABLE
(TEE)

DATE	REVISION OR ISSUE	NO.	BY
		1	

TWO MORRISON-KNUDSEN PLAZA/PO. BOX 7806/BOISE, ID 83729

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SPECIFICATION SECTION 37-1621A

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

POLE MOUNTED TRANSFORMER

CLIENT: SHELL OIL COMPANY

PROJECT: NORTHWEST BOUNDARY SYSTEM IRA

LOCATION: ROCKY MOUNTAIN ARSENAL

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SPECIFICATION SECTION 37-1621A

NORTHWEST BOUNDARY SYSTEM

SHORT-TERM IMPROVEMENTS IRA

POLE MOUNTED TRANSFORMER

1.0 SCOPE OF WORK

- A. This specification covers the design, fabrication, testing and delivery of 1 pole mounted outdoor, liquid-filled transformer or 1 pole mounted indoor/outdoor dry type transformer.
- B. The equipment furnished shall be complete for the specified service indicated herein except for required mounting bolts and installation at the job site.

2.0 RELATED WORK

- A. The following related work, to be performed by others, is covered in other sections of the specifications:
 - 1) Electrical work (Section 37-1601).

3.0 REFERENCE STANDARDS

- 1) ANSI - American National Standards Institute
- 2) ICEA - Insulated Cable Engineers Association
- 3) IEEE - The Institute of Electrical and Electronics Engineers, Inc.
- 4) NEMA - National Electrical Manufacturers Association
- 5) NFPA/
NEC - National Fire Protection Association National Electrical Code
- 6) OSHA - Occupational Safety and Health Administration
- 7) UL - Underwriter's Laboratories, Inc.

4.0 REFERENCE DRAWINGS

- A. The following list of drawings is intended to indicate the general arrangement of the transformers and their location to other equipment.

<u>DRAWING NO.</u>	<u>TITLE</u>
37107-37-001	Electrical - Power Plan, Sections and Details

5.0 AMBIENT CONDITIONS

- A. The equipment specified herein shall be designed and constructed to operate successfully at the rated values under the following conditions:

- 1) Location: Outdoors
- 2) Elevation: 5,215 feet above sea level
- 3) Temperature Range: 40°F to 95°F
- 4) Seismic Zone: UBC1

6.0 EQUIPMENT BIDS

- A. In addition to requirements of the "Vendor Data Requirements - Electrical" sheet, the following information shall be furnished with the bid:
- 1) Preliminary sketch showing general arrangements, weights and dimensions of transformers.
 - 2) Guaranteed maximum losses at the following conditions:
 - a) No-load losses at 100 percent rated voltage.
 - 3) Manufactures minimum standard impedance without additional cost for specified BIL.

7.0 MANUFACTURERS' DRAWINGS

- A. "GENERAL SPECIFICATIONS FOR EQUIPMENT", all information listed below, together with all information noted on the "Vendor Data Requirements - Electrical" sheet (in the quantities shown) shall be submitted for approval:

- 1) Wiring diagrams, instruction booklets, outline and general drawings.

8.0 GENERAL REQUIREMENTS

- A. Material and equipment shall be standard products of established manufacturers who have produced continuously the type of equipment specified. All material and equipment shall be new and of high quality ensuring long life and reliable operation.

9.0 SPECIFIC REQUIREMENTS

- A. The platform outlined and pole mounted transformers shall be designed, manufactured and tested in accordance with the 1990 applicable NEMA and ANSI standards.
- B. The transformers shall be outdoor, oil filled, conventional distribution type, single phase units with two, wet-process porcelain, high voltage bushings and low voltage tank-wall bushings.
- C. Transformers shall have KVA ratings as indicated on the drawings or herein specified and manufacturers' standard accessories and color.
- D. The transformer unit supplied shall be suitable for the location and climatic conditions which prevail at the site. All protective devices shall have ratings compatible with the associated transformer ratings. The transformer unit shall be assembled and coordinated by one manufacturer. The transformer unit shall be built and shipped as a complete unit.
- E. The transformers shall be designed to permit continuous operation at 100% of rated capacity with 55 degree (C) temperature rise above a 30 degree (C) ambient. It shall also be rated to operate continuously at 112% rated capacity with a 65 degree (C) self-cooled rise above ambient.

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- F. Transformer shall be of the liquid filled type, and be furnished complete with oil or be a dry type, epoxy potted, approved for outdoor operation.
- G. All transformer oil shall be of the manufacturer's standard, provided it meets or exceeds all applicable requirements and test of the codes and standards specified herein. Oil shall not contain any PCB's (Polychlorinated Biphenels).
- H. All transformer service and equipment openings shall have suitable gaskets. Gasketed joints for tank cover, service openings, bushings and other bolted attachments shall be designed in such a manner that gaskets will not be exposed to the weather.
- I. The transformers shall be furnished with grounding pads in accordance with ANSI requirements.
- J. The transformers secondary winging shall be brought out through a bushing for solid grounding.

10.0 CONSTRUCTION

- A. High voltage bushing terminals shall be tin-plated to minimize galvanic action and have spring foll-up in order to accommodate copper or aluminum conductors. Two stainless-steel coned-disk Belleville washers shall maintain contact pressure on the high-voltage leads.
- B. Transformer coil assemblies shall be designed for effecting operation at 65 degrees (C). Core clamps shall be bolted securely to lugs welded to the tank wall.
- C. Tap changers shall be provided on all transformers and shall be 2-2 1/2% FCBN and 2-2 1/2% FCAN. The tap changers operating handle and dial shall be above the oil level and shall be easily read and operated through handhole provided.
- D. The tanks shall be manufactured from shot blasted, hot rolled steel and pressure tested to assure freedom from leaks. The tanks shall be cleaned and painted with three coats of the manufacturer's standard paint.
- E. Manufacturer shall apply an insulating material to the transformer to help prevent outages caused by birds and squirrels coming in contact with a line terminal and

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A DIVISION OF MK-FERGUSON

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the cover. It shall be applied to the main and handhold cores as well as the cover clamping bands.

- F. The tank rim shall form a contoured gasket seat which, in combination with the drawn cover shall allow the nitrite rubber gasket to form a permanent, even seal.
- G. A one-piece clamping band shall be provided for the covers of all transformers through 100 KVA. Cover bolt clamps shall be used on the covers of the 500 KVA units.
- H. Lifting lugs shall be welded to the tank wall and shall be strong to support the finished transformer with oil and shall be designed to withstand normal impact loading associated with lifting operations.
- I. Transformers shall be provided with low voltage grounding pads and designed so that a bolt cannot be forced through the tank wall.
- J. Manufacturer shall furnish a nameplate with all standard characteristics in an easy to read position on either the lower hanger bracket or on a bracket on the transformer tank.
- K. A pressure vent plug shall be provided on all transformers.

11.0 INSPECTION AND TESTING

- A. All standard routing tests as identified and described by ANSI and NEMA standards.

12.0 SHIPPING AND HANDLING

- A. Any parts that might be damaged in shipment, shall be securely blocked, tied, braced and packed to prevent damage.
- B. Any component shipped separately shall be properly identified to facilitate field installation.
- C. Prior to shipping, all transformers filled with insulating liquids shall have drains and fill ports checked to ensure no leakage of insulating liquid occurs during shipment.

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APPENDIX A

TRANSFORMER DATA SHEET

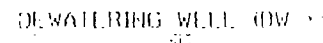
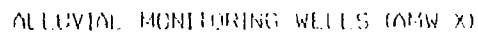
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Service: _____
Tag No.: _____
Nameplate ratings: _____ KVA, OA
Temperature _____ degree C rise
Impulse Level _____ KV, BIL
Impedance _____ %
H.V. Connections _____ V., _____ V.,
_____ V., _____ V.
L.V. Connections _____ V.
Mfr./Model No.: _____
Type: _____
Size: (Max.) Width _____ in., Height _____ in.,
Depth _____ in.
Weight: _____ lbs.
Sound Level: _____ db @ _____ ft.
Insulating Liquid:
Mfr./Type _____/
Dielectric Strength: _____ KV
X/R Ratio: _____

RMA REMEDIATION PROJECT IRA FINAL DETAILED DESIGN
NORTHWEST BOUNDARY SYSTEM SHORT-TERM IMPROVEMENTS
DRAWING SCHEDULE

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2. 37107-34-002 Well Construction Data
3. 37107-35-001 Discharge Well Valve Pit and Piping Plan and
Sections
4. 37107-37-001 Electrical Power Plan Sections and Details

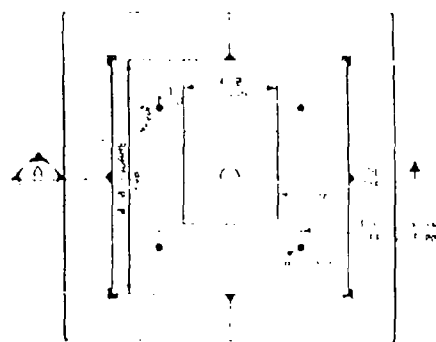
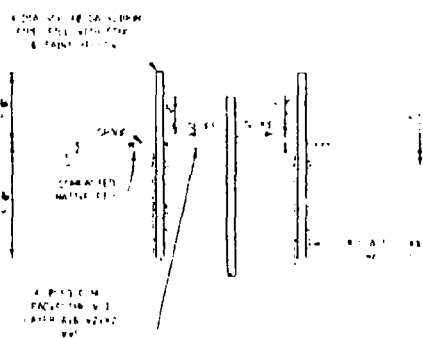
WORK ORDER		24 X 36
2127		
DRAWING NO. 57107 34 01		
REFERENCE NO.	REV	
0001	0	



WELL	COORDINATES	APPROX DEPTH (FEET)
ALW 1	N 93 W E 2 1/2 S 86	37

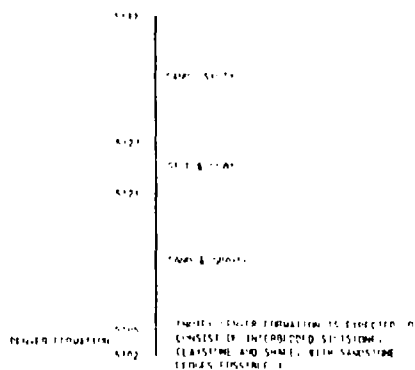
WEI:	DOB: DATE:	AGE:	DEPT:	OFF:
DW 16	8-22-54 12-26-55	40		
DW 17	8-28-38 12-26-63	36		

[illegible]

SURFACE CHARACTERIZATION
OF DEWATERING ZONES

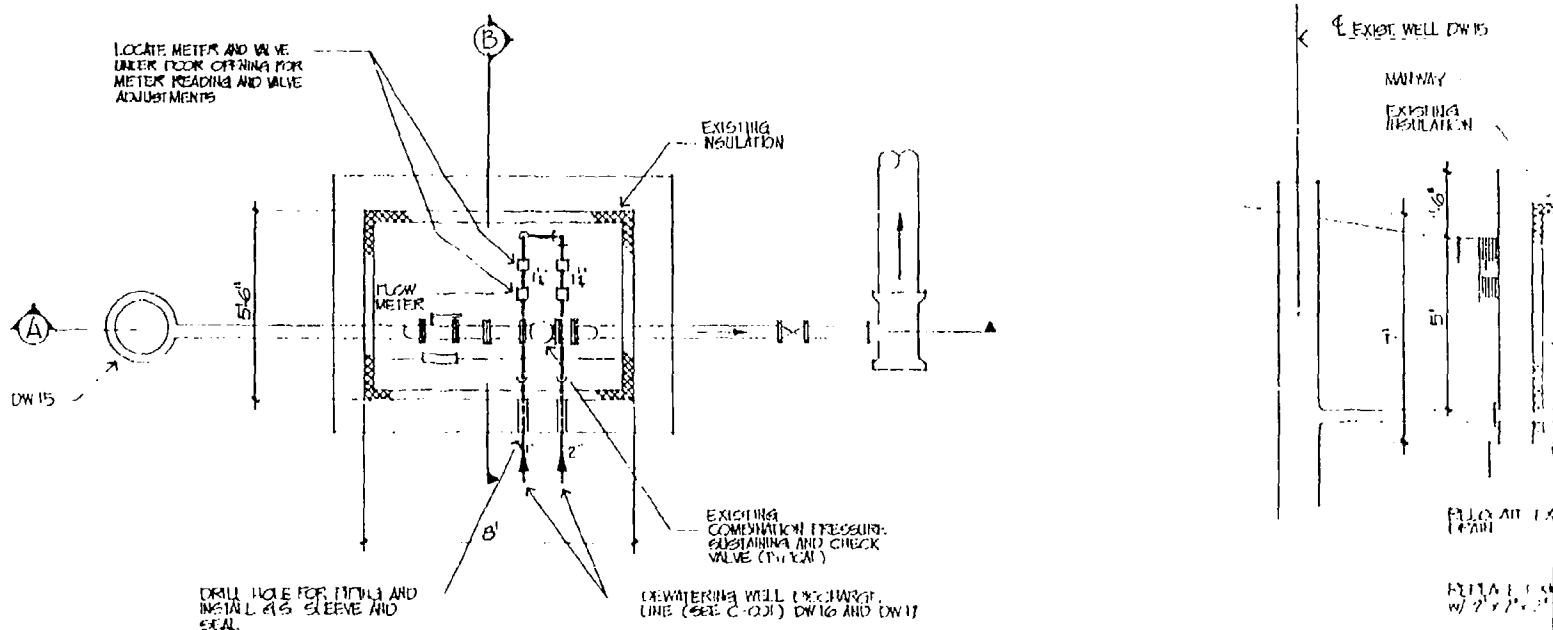
SECTION 40 V

EATING WELL (DW X)

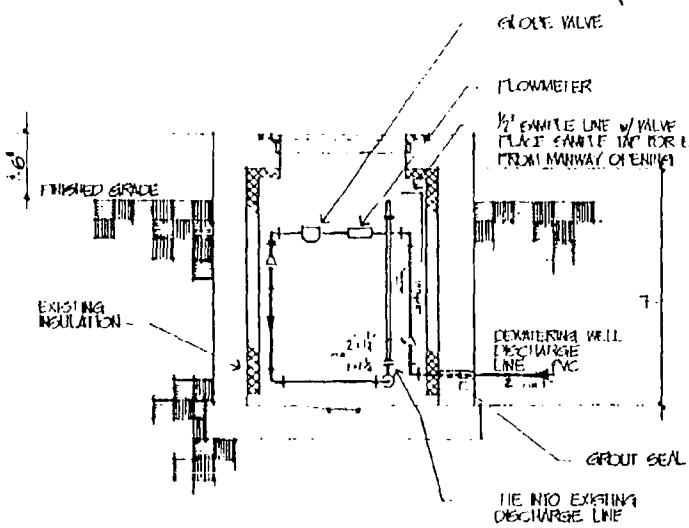


DECEMBER 19
 1944
 WELL 2505
 VOLUME
 PROPERTY
 DE WETERING
 WELL (DOW 12)
 115

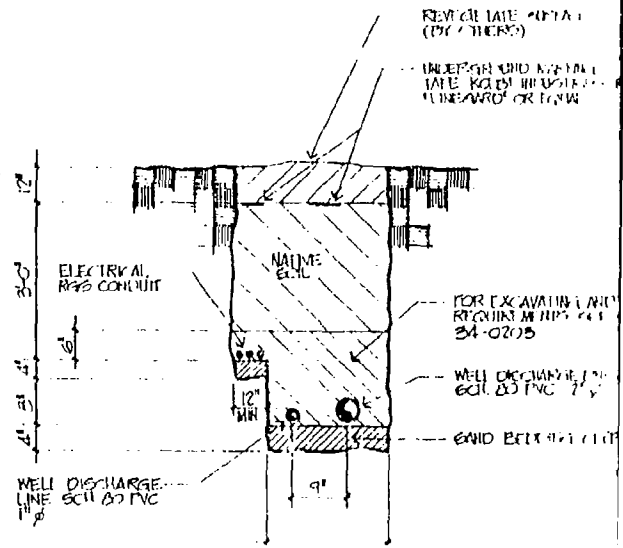
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PLAN/EXHAUSTIVE WELL VALVE TYPICAL ARRANGEMENT (TYPICAL) NOT TO SCALE

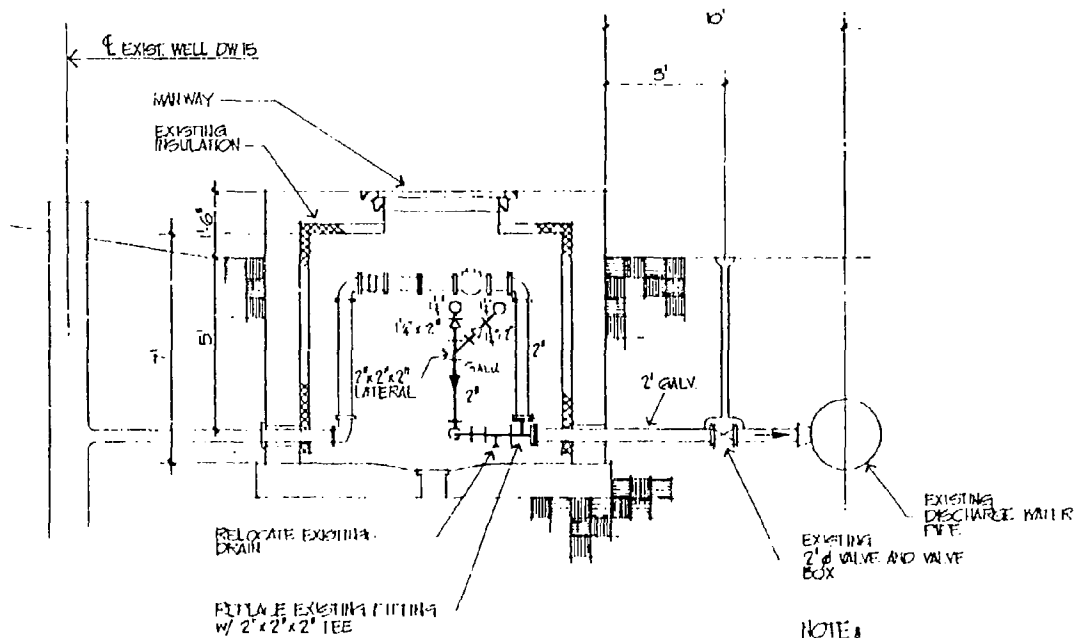


SECTION B NOT TO SCALE



SECTION C NOT TO SCALE

NO.	BY	DATE	CHKD	DESCRIPTION	DEPT	REV	A	O	SCALE	APPROVALS	DESIGNED	CHECKED	CL
E 001	PM	15-10-90	JB	ISSUE FOR IMPLEMENTATION	ARCH								
C 002	PM	15-11-90	JB	FOR REVIEW & COMMENT	CIV/STRL								
C 001	PM	15-11-90	JB		MECH								
					ELECT								
					INST								
					PIPING								
					SAFETY								
					GEOSC								
					DEPT MGR								
					PROJECT								



SECTION (A)
NOT TO SCALE

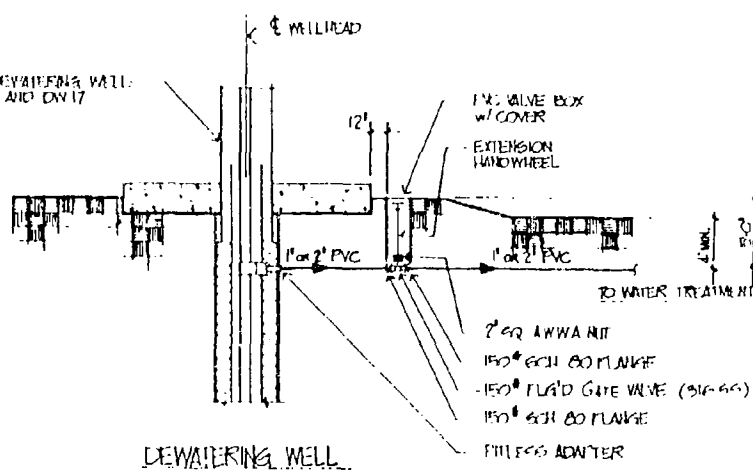
NOTE:
LOCATE SAMPLE VALVE, METER AND GLOBE VALVE AS NEAR THE EXISTING VALVE & FITTING AS POSSIBLE FOR READING AND VALVE ADJUSTMENT.

REVEGETATE SURFACE (BY OTHERS)
UNDERGROUND MARKING TAPE KOLB INDUSTRIES RED "LINEAR" OR EQUAL

FOR EXCAVATING AND BACKFILLING REQUIREMENTS SEE SPECIFICATION 34-0205

WELL DISCHARGE LINE 60" OD PVC 2' Ø
SAND BEDDING (10')

NEW DRAINAGE WALL DW 16 AND DW 17



DEWATERING WELL

DETAIL (2)
NOT TO SCALE

SECTION (C)
NOT TO SCALE

REV	BY	DATE	SCALE	AS SHOWN	DATE
1	A	0			
2	A	0			
3	A	0			
4	A	0			
5	A	0			
6	A	0			
7	A	0			
8	A	0			
9	A	0			
10	A	0			
11	A	0			
12	A	0			
13	A	0			
14	A	0			
15	A	0			
16	A	0			
17	A	0			
18	A	0			
19	A	0			
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22	A	0			
23	A	0			
24	A	0			
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26	A	0			
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42	A	0			
43	A	0			
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45	A	0			
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49	A	0			
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100	A	0			

MK-ENVIRONMENTAL SERVICES
A DIVISION OF MCFERSON

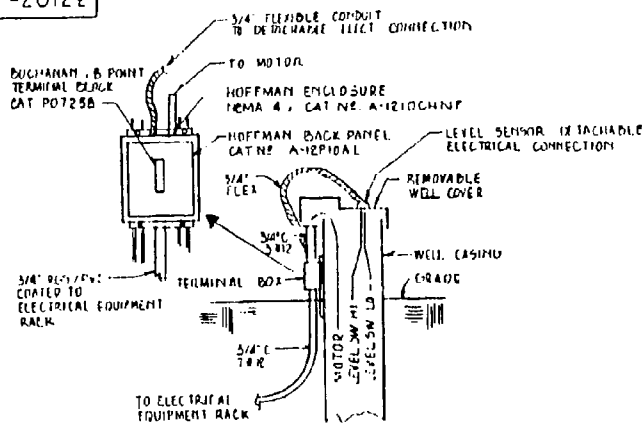
SHELL OIL COMPANY
ROCKY MOUNTAIN ARSENAL REMEDIATION PROJECT
INTERIM RESPONSE ACTION FINAL DETAILED DESIGN

NORTHWEST BOUNDARY SYSTEM
SHORT-TERM IMPROVEMENTS

DISCHARGE WELL VALVE FIT & PIPING
PLAN & SECTIONS

WORK ORDER	2127	24 x 36
DRAWING NO.	3/107-35 (A)	
REFERENCE NO.	P 001	(1)

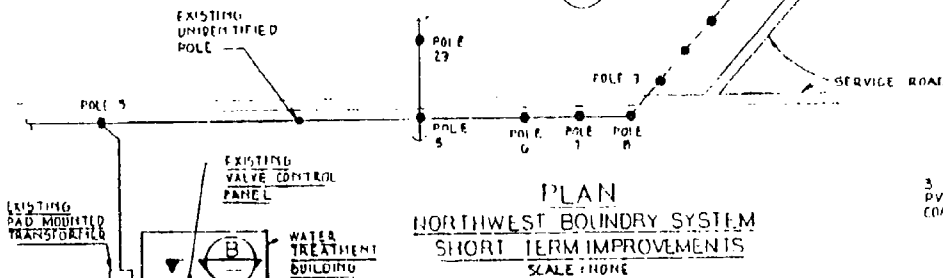
100-25-2012C



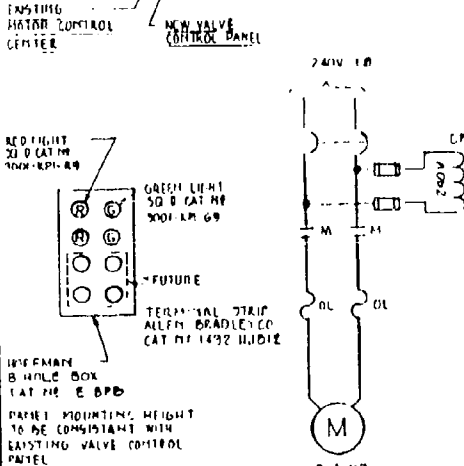
TYPICAL FOR DW16 & DW17
DETAIL (1)
SCALE: NONE



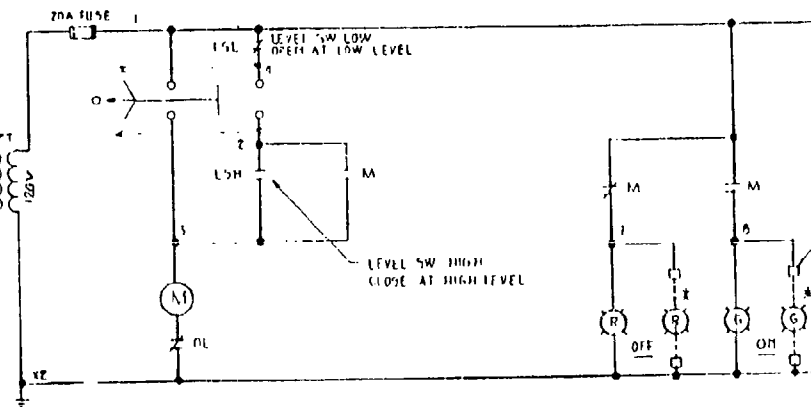
ELEVATION (B)
SCALE: NONE



PLAN
NORTHWEST BOUNDARY SYSTEM
SHORT TERM IMPROVEMENTS
SCALE: NONE

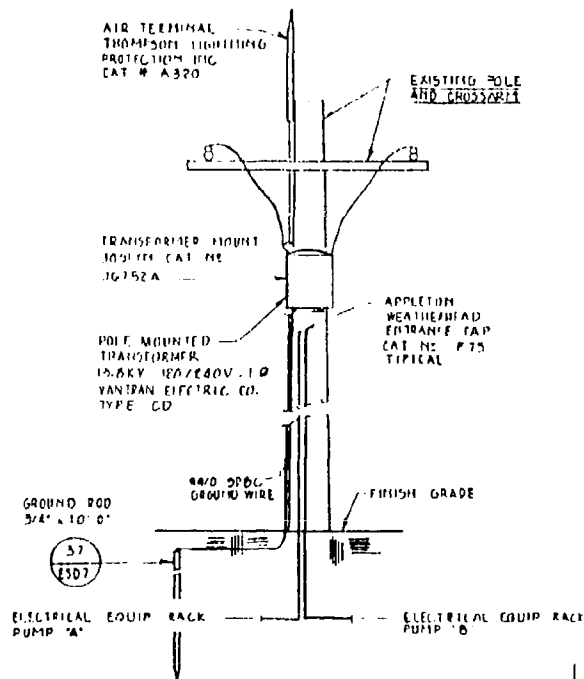
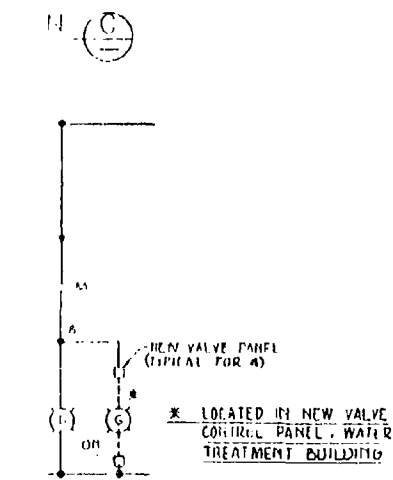



DETAIL (2)
SCALE: NONE
(REF SECTION B)



TYPICAL DW16 & DW17
DISCHARGE WELL CONTROL DIAGRAM
SCALE: NONE

REFERENCE DWS	REVISIONS	DEPT	REV	A	O	SCA	UR	DES	CH	RET
C-002	WELL CONSTRUCTION DATA	ARCH								
C-001	TRENCH PLAN PROFILE & DETAILS	CIV/STRL								
DRAWING NO.	TITLE	MECH								
		ELECT								
		INSTR								
		PIPING								
		SAFETY								
		GEOSC								
		DEPT HDR								
		PROJECT								

[illegible]

 **MK-ENVIRONMENTAL SERVICES**
A DIVISION OF MK FERGUSON

SHELL OIL COMPANY
ROCKY MOUNTAIN ARSENAL REMEDIATION PROJECT
INTERIM RESPONSE ACTION FINAL DETAILED
DESIGN

NORTHWEST BOUNDARY SYSTEM SHORT TERM IMPROVEMENTS	CONTRACT NO.	24 X 36
	DRAWING NO.	37107-37 (001)
DRAWING TITLE		REFERENCE NO.
ELECTRICAL POWER PLAN SECTIONS AND DETAILS		REV 0